TOSHIBA

6F8A0789

ELECTROMAGNETIC FLOWMETER FOR PARTIALLY FILLED PIPES

MODEL LF502

INSTRUCTION MANUAL

TOSHIBA CORPORATION

NOTICE

This Manual is designed to assist in installing, operating, and maintaining the LF502 Electromagnetic Flowmeter for Partially-filled Pipes. For safety reasons, and to obtain the optimum performance from the flowmeter, read this Manual thoroughly before working with the product. Keep the Manual within easy reach for reference whenever needed.

The flowmeter to which this Manual refers is NOT designed for applications in which the functioning of this product is critical to human safety, such as:

- Main control systems of nuclear power plants; safety systems in nuclear facilities or other critical control lines directly affecting human safety.
- Control systems of medical equipment, including life support machines.

NOTES

1. The reproduction of the contents of this Manual in any form, whether wholly or in part, is not permitted without explicit prior consent and approval.
2. The information contained in this Manual is subject to change or review without prior notice.
3. Be sure to follow all safety, operating and handling precautions described in this Manual and the regulations in force in the country in which this product is to be used.

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SAFETY PRECAUTIONS

Safety signs and labels affixed to the product and/or described in this manual give important information for using the product safely. They help prevent damage to property and obviate hazards for persons using the product.

Make yourself familiar with signal words and symbols used for safety signs and labels. Then read the safety precautions that follow to prevent an accident involving personal injury, death or damage to property.

Explanation of signal words

The signal word or words are used to designate a degree or level of hazard seriousness. The signal words used for the product described in this manual are WARNING and CAUTION.

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor to moderate injuries or in property damage.

Safety symbols

The following symbols are used in safety signs and labels affixed to a product and/or in the manual for giving safety instructions.

	Indicates an action that is prohibited. Simply DON'T do this action. The prohibited action is indicated by a picture or text inside or next to the circle
	Indicates an action that is mandatory. DO this action. The mandatory action is indicated by a picture or text inside or next to the circle.
	Indicates a potential hazard. The potentially hazardous situation is indicated by a picture or text inside or next to the triangle.

SAFETY PRECAUTIONS (continued)

Safety Precautions for Installation and Wiring

⚠ WARNING

■ Do not use the LF502 in an **explosive atmosphere.**

DON'T

Using this product in an explosive atmosphere can cause **explosion.**

⚠ CAUTION

■ **Turn off mains power** before working on pipes.  DO Working on pipes while power is applied can cause **electric shock.**	■ Use an **appropriate device** to carry and install the LF502.  DO If this product **falls to the ground**, injury, or malfunction of or damage to the product, can be caused.
■ **Install a switch and fuse** to isolate the LF502 from mains power.  DO Power supply from mains power can cause **electric shock** or **circuit break-down.**	■ **Do not modify or disassemble** the LF502 unnecessarily.  DON'T Modifying or disassembling this product can cause **electric shock, malfunction of or damage to this product.**
■ **Turn off mains power** before conducting wiring work.  DO Wiring while power is applied can cause **electric shock.**	■ **Ground** the LF502 **independently from power equipment.**  DO Operating this product without grounding can cause **electric shock** or **malfunction.**
■ Do not conduct wiring work **with bare hands.**  DON'T **Remaining electric charge** even if power is turned off can still cause **electric shock.**	■ Use **crimped terminal lugs** for the terminal board and GND terminal.  DO Loose connections can cause **electric shock, fire from excessive current or system malfunction.**
■ Do not work on piping and wiring **with wet hands.**  DON'T Wet hands may result in **electric shock.**	 The label shown left is placed near the terminal board for power input. (A black border and symbol on yellow triangle) Be alert to **electric shock.**

SAFETY PRECAUTIONS (continued)

Safety Precautions for Maintenance and Inspection

⚠ CAUTION	
■ Do not touch the LF502 main body when **high temperature fluid** is being measured. DON'T The fluid raises the main body temperature and can cause **burns** when touched.	■ Do not conduct wiring work when **power is applied**. DON'T Wiring while power is applied can cause **electric shock**.
■ Do not conduct wiring work **with wet hands**. DON'T Wet hands may result in **electric shock**.	 The label shown left is placed near the terminal board for power input. (A black border and symbol on yellow triangle) Be alert to **electric shock**.
■ Do not use a **fuse other than the one specified**. DON'T Using a fuse other than the one specified can cause **system failure, damage or malfunction**.	Use a rated fuse as follows: **Fuse rating:** • 1A/250V for 100 to 240Vac • 2A/250V for 24 V dc **Dimensions:** Diameter 5.2 mm × 20 mm **Melting time characteristic:** Normal blow

Disclaimer

Toshiba does not accept liability for any damage or loss, material or personal, caused as a direct or indirect result of the operation of this product in connection with, or due to, the occurrence of any event of force majeure (including fire or earthquake) or the misuse of this product, whether intentional or accidental.

Handling Precautions

■ To obtain the optimum performance from the LF502 flowmeter for years of continuous operation, observe the following precautions.

(1) Do not store or install the flowmeter in:

- places where there is direct sunlight. If this is unavoidable, use an appropriate sunshade.
- places where excessive vibration or mechanical shock occurs.
- places where high temperature or high humidity conditions obtain.
- places where corrosive atmospheres obtain.
- places submerged under water.

To put the flowmeter temporarily on the floor, place it carefully with something to support it so that the flowmeter will not topple over.

(2) Execute wiring securely and correctly.

Ground the flowmeter with 100 ohm or less ground resistance. Avoid a common ground used with other equipment where earth current may flow. An independent ground is preferable

(3) Seal the cable thoroughly at the cable gland so that the cable is kept airtight.

(4) .The converter housing covers and the cable glands are tightened securely at the time of shipment. Do not remove these covers or glands unless it is necessary to wire new cables or replace old ones. Otherwise, gradual deterioration of circuit isolation or damage to this product can be caused. Tighten the covers or cable glands securely again if they have been removed.

(5) Make sure the fluid to be measured will not freeze in the detector pipe. This can cause damage to the detector pipe.

(6) Select appropriate wetted materials suited for the process fluid to be measured. Otherwise, fluid leakage due to corrosion can be caused.

Handling Precautions (continued)

(7) Observe the following precautions when you open the converter housing cover:

- Do not open the cover in the open air unprotected against rain or wind. This can cause electric shock or cause damage to the flowmeter electronics.
- Do not open the cover under high ambient temperature or high humidity conditions or in corrosive atmospheres. This can cause deterioration of system accuracy or cause damage to the flowmeter electronics.

(8) This product may cause interference to radio and television sets if they are used near the installation site. Use metal conduits etc. for cables to prevent this interference.

(9) Radio transmitters such as transceivers or cellular phones may cause interference to the flowmeter if they are used near the installation site. Observe the following precautions when using them:

- Do not use a transceiver whose output power is more than 5 W.
- Move the antenna of a transceiver or a cellular phone at least 50 cm away from the flowmeter and signal cables when using it. Do not use a radio transmitter or a cellular phone near the flowmeter while it is operating online. The transmitter or cellular phone's output impulse noise may interfere with the flowmeter.
- Do not install a radio transmitter antenna near the flowmeter and signal cables.

(10) For reasons of flowmeter failure, inappropriate parameters, unsuitable cable connections or poor installation conditions, the flowmeter may not operate properly. To prevent any of these problems causing a system failure, it is recommended that you have preventive measures designed and installed on the flowmeter signal receiving side.

Table of Contents

1. Product Inspection and Storage

Upon arrival of the product package, open the package and check the items contained inside. If you do not intend to install the product soon after opening the package, store the product and other related items in a place such as described in 1.2 below.

1.1 Product Inspection

The LF502 electromagnetic flowmeter is shipped in a cardboard container filled with shock-absorbing materials. Open the package carefully and check as follows:

- Make sure the following items are included in the package.

  (1) Model LF502 Electromagnetic Flowmeter..... 1
  (Detector 1, Converter 1)

  (2) Instruction Manual 1

- Inspect the flowmeter for indications of damage that may have occurred during shipment.
- Make sure the type and specifications of the flowmeter are in accordance with the ordered specifications.

If you cannot find the items listed above or any problem exists, contact your nearest Toshiba representative.

1.2 Storage

To store the LF502 flowmeter after opening the package, select a storing place as follows and keep it under the conditions described below:

(1) Avoid places where there is direct sunlight, rain or wind.

(2) Store the product in a well-ventilated place. Avoid places of extremely high humidity or extremely high or low temperature. The following environment is recommended:

- **Humidity range: 10 to 90% RH (no condensation)**
- **Storage temperature: –15 to +65° C**

(3) Avoid places where vibrations or mechanical shock occur.

(4) Do not leave the converter housing cover open. Open the cover only when you actually start wiring cables. Leaving the cover open can cause gradual deterioration of circuit isolation.

(5) To put the flowmeter temporarily on the floor, place it carefully with something to support it so that the flowmeter will not topple over.

2. Overview

The LF502 electromagnetic flowmeter measures the volumetric flow rates of electrically conductive materials on the basis of Faraday's Law of electromagnetic induction.
The device consists of two units: the detector, through which the fluid to be measured flows, and the converter, which receives the electromotive force signals from the detector, then converts the signals into the 4–20 mA dc signal.

Features

The electromagnetic flowmeter has the following features:

- Fluid flow is not obstructed and pressure loss is negligible.
- The process fluid's temperature, pressure, density or flow conditions has no effect on the accuracy of the flowmeter.
- The flowmeter output is directly proportional to the process flow rate, thus it is easy to read its output.

In addition to them, model LF502 has following excellent features:

(1) Measures fluid from low to full level with high accuracy.

(2) No obstacle is designed inside pipe that allows less sludge, mud and slurry heaping.

(3) Allows less affect from scam on fluid surface and waves since this is not designed for liquid level measurement.

(4) Measures flow rate without filling up the pipe as in previous version.

(5) The flowmeter has various flow measurement output and control functions as standard specifications and the optional LCD display for convenient parameter settings.

- These functions can be selected with control keys on the panel.
- The widely used HART protocol communications system is used as a standard feature. HART (Highway Addressable Remote Transducer) is a communications protocol for industrial sensors recommended by HCF (HART Communication Foundation).
- An easy-to-read LCD display (2-line × 16-character display) (optional)
  The backlit LCD display can be read even under poor lighting conditions.

3. Names of Parts

The view of the LF502 flowmeter detector is shown in Figure 3.1 and the views of the converter are shown in Figures 3.2 and 3.3.

3.1 View of Detector

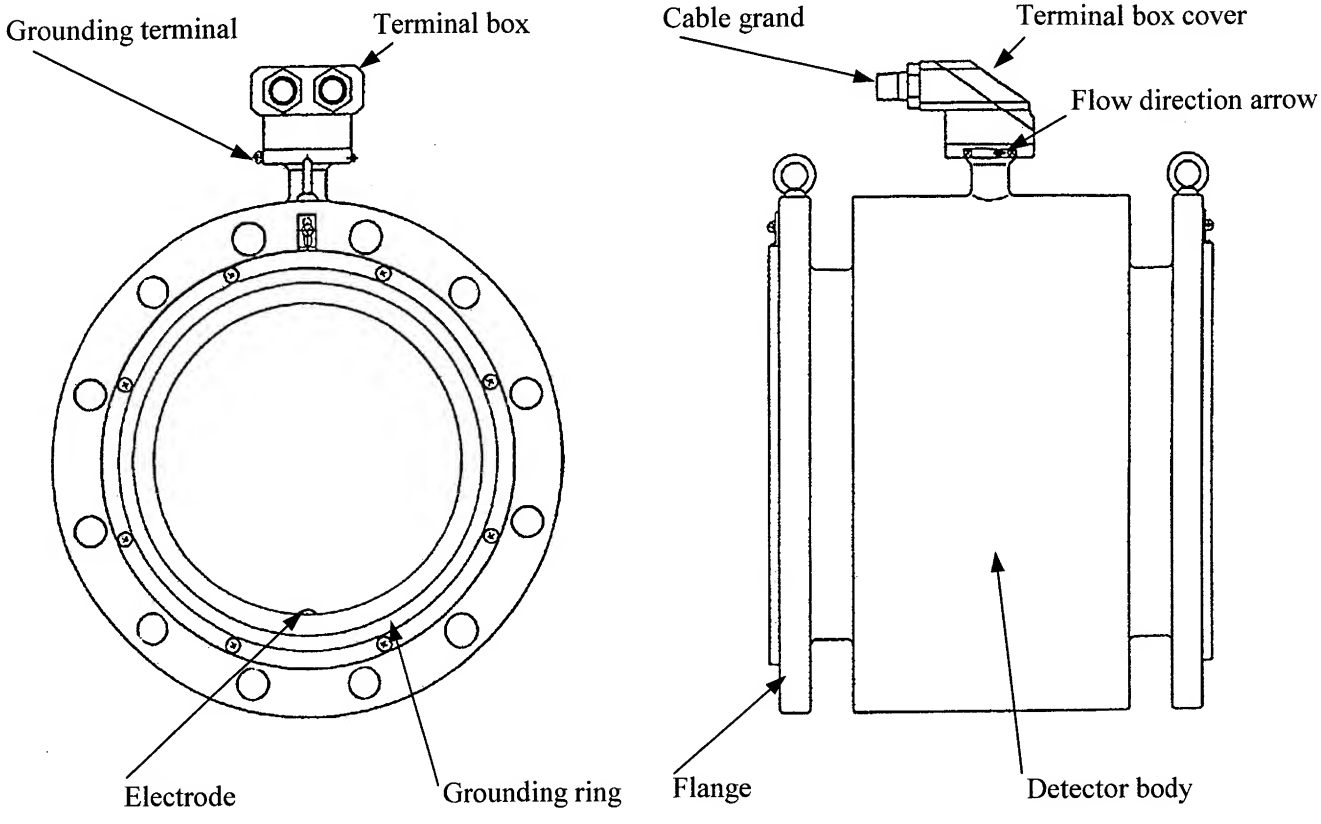


Figure 3.1 Outline drawing of LF502 Detector

3.2 View of Converter

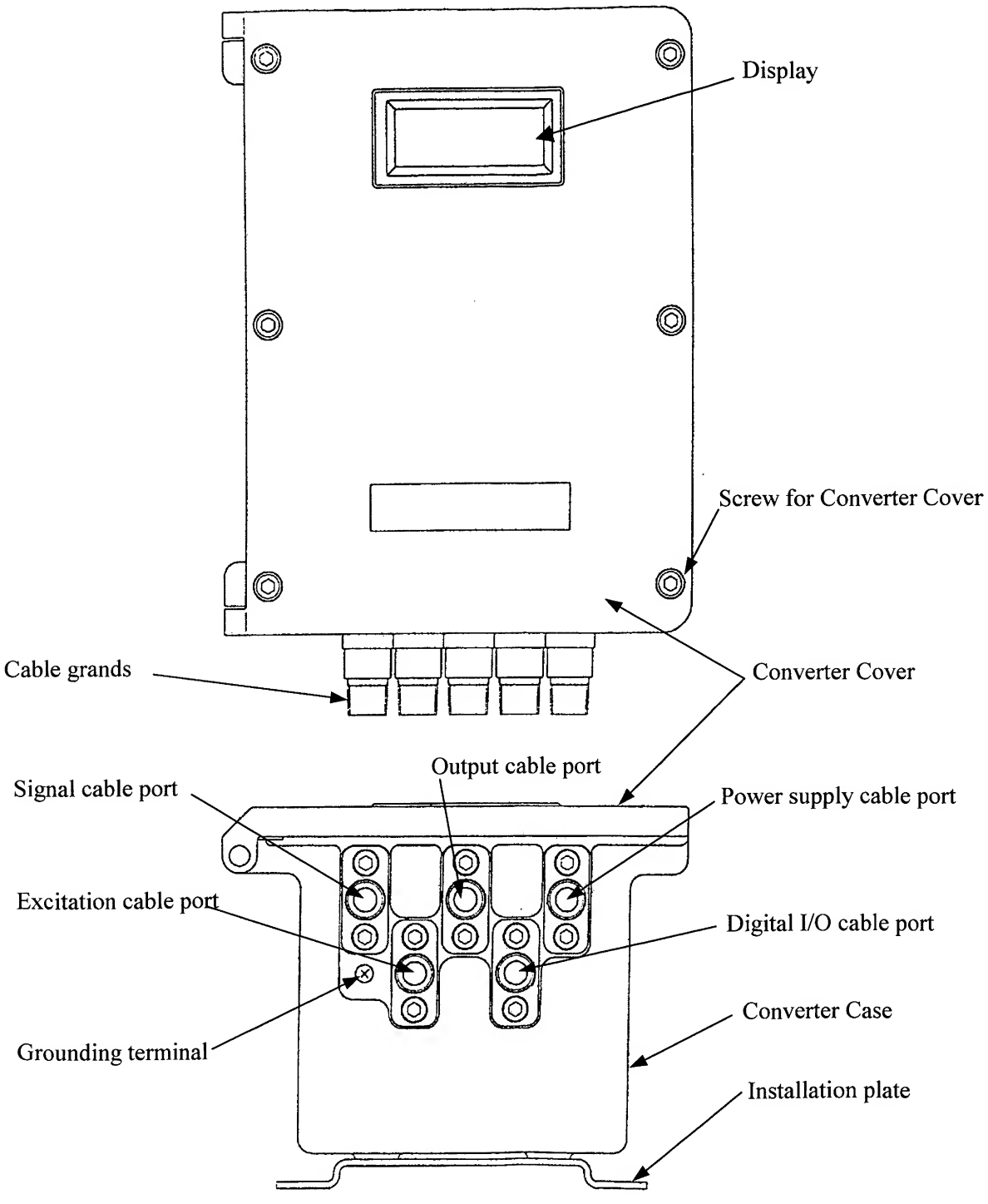


Figure 3.2 Outline drawing of LF502 Converter

3.3 Internal Details of Converter

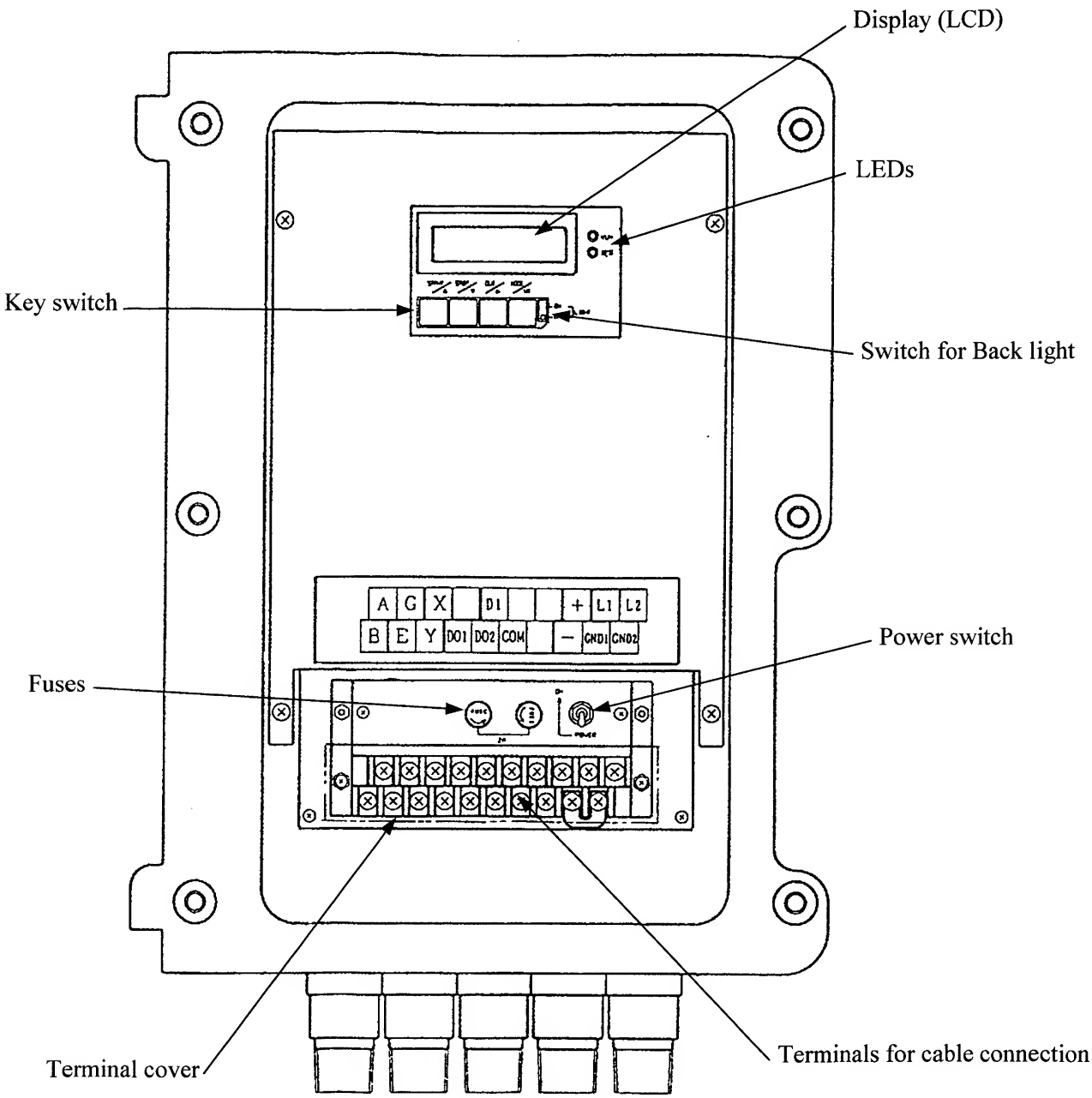


Figure 3.3 Internal Details of Converter

4. Installation

Safety Precautions for Installation

⚠ WARNING
■ Do not use the LF502 in an **explosive atmosphere.**  DON'T Using this product in an explosive atmosphere can cause **explosion.**

⚠ CAUTION	
■ **Install a switch and fuse to isolate the LF502 from main power.**  DO Power supply from main power can cause **electric shock** or **circuit breakdown.**	■ **Use an appropriate device to carry and install the LF502.**  DO If his product **falls to the ground**, injury, or malfunction of or damage to the product, can be caused.
■ **Do not modify or disassemble the LF502 unnecessarily.**  DON'T Modifying or disassembling this product can cause **electric shock, malfunction or damage to this product.**	■ **Ground the LF502 independently from power equipment.**  DO Operating this product without grounding can cause **electric shock** or **malfunction.**
■ **Do not work on piping and wiring with wet hands.**  DON'T Wet hands may result in **electric shock**	 The label shown left is placed near the terminal board for power input. (A black border and symbol on yellow triangle) Be alert to **electric shock.**

4.1 Location

To select the installation site, follow the precautions described below:

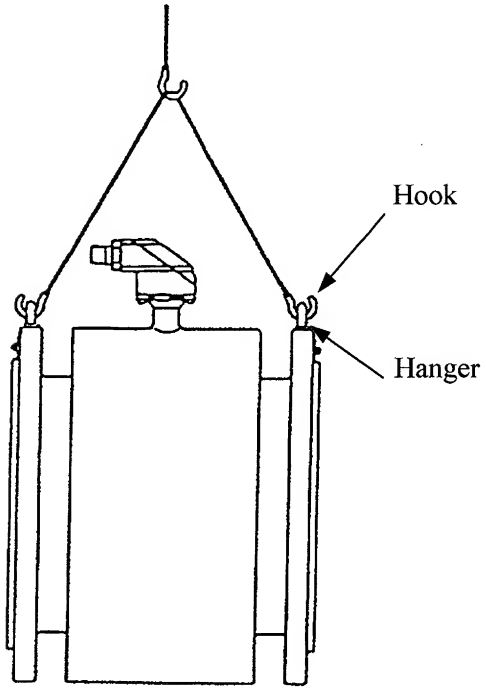
- Avoid places where fluid runs in a pulsating form.
- Avoid places within the immediate proximity of equipment producing electrical interference (such as motors, transformers, radio transmitters, electrolytic cells, or other equipment causing electromagnetic or electrostatic interference).
- Avoid places where excessive pipe vibration occurs.
- Avoid places where there is direct sunlight. If this is unavoidable, use an appropriate shade
- Avoid places where corrosive atmospheres or high humidity conditions obtain.
- Avoid places of too great an elevation or constricted areas where clearance for installation or maintenance work is not provided.
- The LF502 detector has no adjustable piping mechanism. Install an adjustable short pipe where needed.
- Chemical injections should be conducted on the downstream side of the flowmeter.

4.2 Mounting Procedure

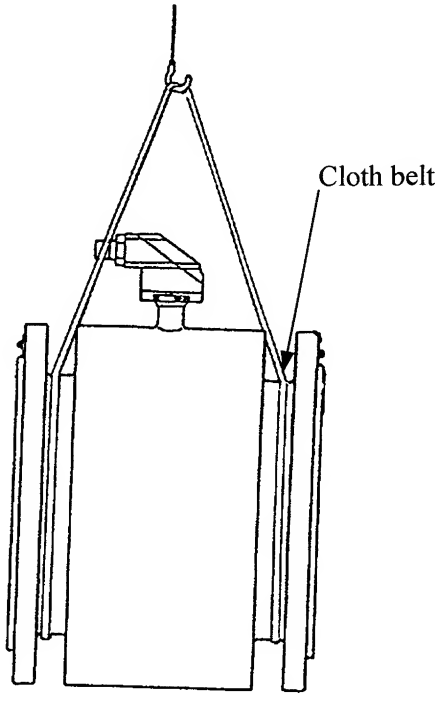
⚠ CAUTION	
■ **Use an appropriate device to carry and install the LF502.**  DO If his product **falls to the ground**, injury, of malfunction of or damage to the product, can be caused.	■ **Turn off mains power before working on pipes.**  DON'T Working on pipes while power is applied can cause **electric shock**.

Electromagnetic flowmeter has two detectors: the one diameter ranges from 200 to 600 mm with hanger, and another diameter is 150 mm without hanger.

- Hook wire to hanger on detector to hang with crane.
- Put cloth belt around detector without hanger to hang with crane.
  Note: Hang this detector carefully not to cause external/internal damage and do not use wire rope.



Detector with hanger (Diameter: 200 to 600mm)



Detector without hanger (Diameter: 150mm)

4.2.1 Flange Connection

Locate flanges on both ends of detector to connect to pipe with packing which is tightened by connection bolts as shown in Figure 4.1. Refer to Table 4.1 for applying bolt sizes, numbers and recommendable torque value. Tighten bolts diagonally and evenly.

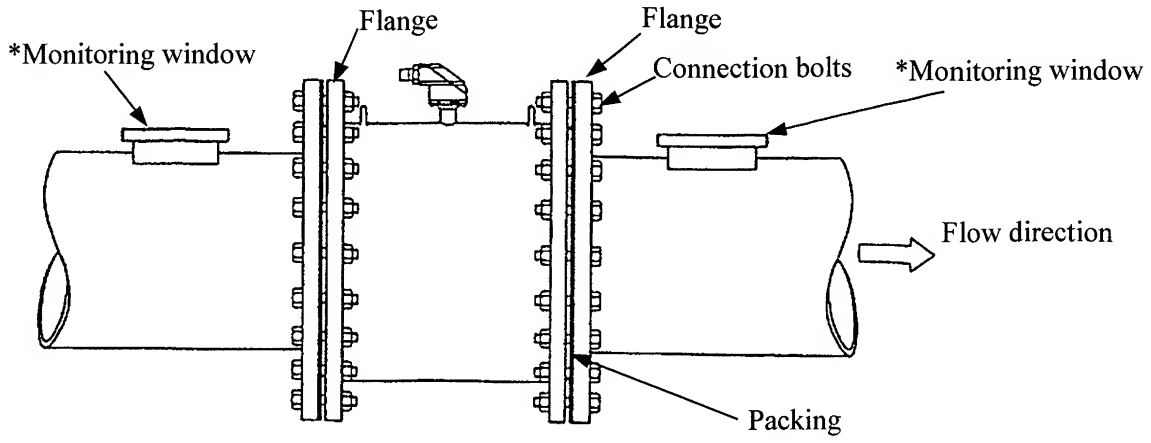


Figure 4.1 Flange connection

*It is recommendable to install monitoring windows which flow direction (either forward or reverse) can be monitored and enables solid substances removal.

When pipe is filled up with fluid that may cause leakage from window, cover window with transparent material including acrylic board.

Table 4.1 Applying bolt sizes, numbers, recommendable torque value and flange, detector diameter

Meter size	JIS 10K	
	Bolt numbers x size x length*2	Recommendable torque value (N•m) *3
150 mm (6 in)	8 x M20 x 75	50 to 60
200 mm (8 in)	12 x M20 x 75	50 to 60
250 mm (10 in)	12 x M22 x 80	80 to 90
300 mm (12 in)	16 x M22 x 80	80 to 90
400 mm (16 in)	16 x M24 x 95	135 to 145
500 mm (20 in)	20 x M24 x 120	150 to 190
600 mm (24 in)	24 x M30 x 130	220 to 260

*1: Equivalent to JIS G 3451 F12

*2: Length is assumed for connection without washer.

*3: Torque value is for new bolts and nuts. Recommendable value for used bolts and nuts will be from 1.7 times to twice as high as indicated in table.

*Please use the following packing when you do not choose packing for piping. Please replace packing once you remove it from pipe and want to install again. Packing specification: JIS K 6353-I A or equivalent

Hardness: Hs 55 - 65°

Material: EPDM rubber

Insert packing between wall and both ends of detector and tighten directly with bolts to install detector on wall of manhole pit as shown in Figure 4.2.

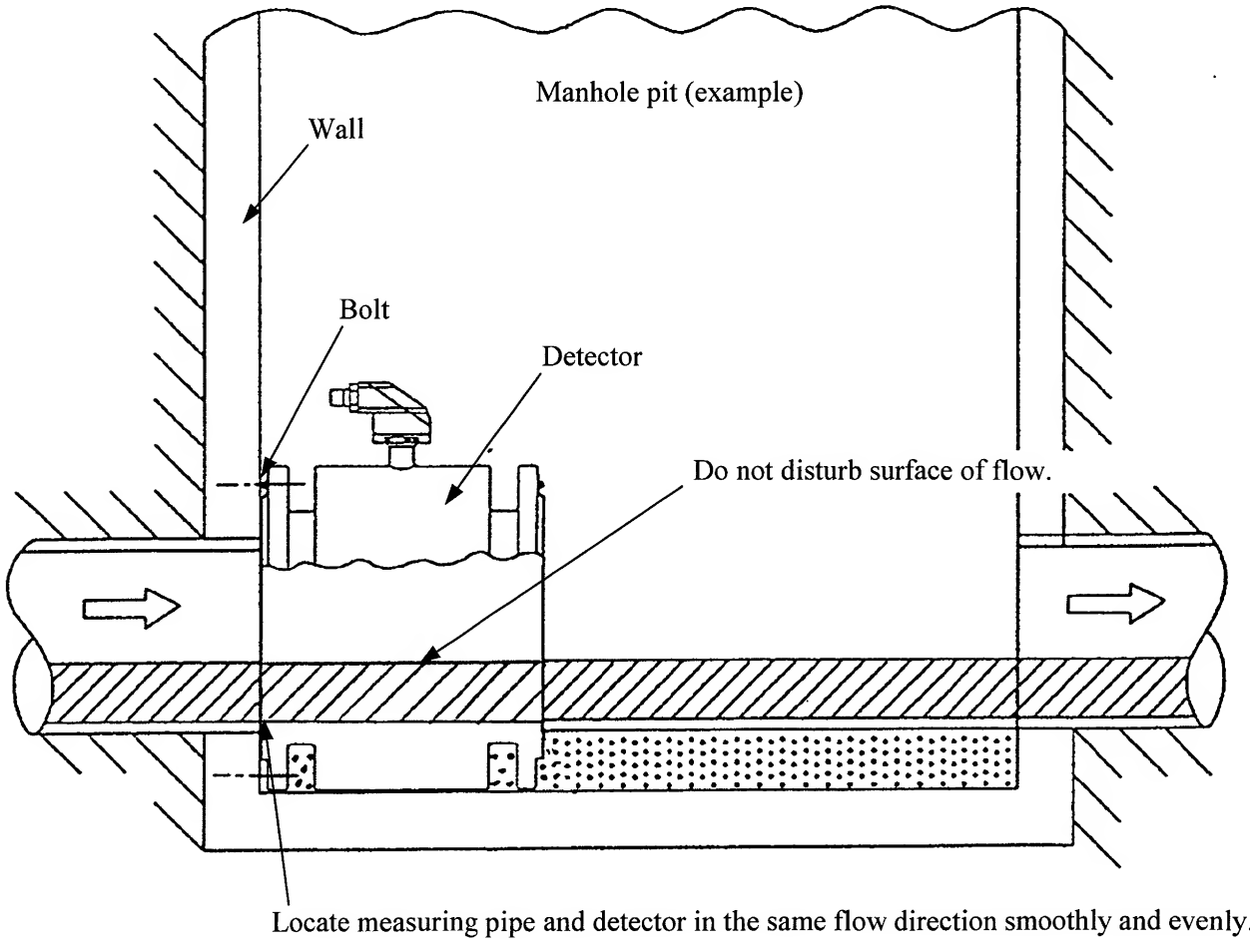


Figure 4.2 Installing detector on manhole

Note 1: Allows no gap between pipe and detector. Locate detector in the same degree as pipe inclined to make fluid flow flatly.

Note2: Remove protrusion if found in forward direction within range of 10D (diameter) from detector.
Remove any protrusion or solid substances which disturb fluid flow in forward direction through detector within 10D or in reverse direction within 5D from detector if found.
Disturbing flow or heaping inside pipe will cause error in measurement.

4.2.2 Warnings for Detector Installation

(1) Install pipe section in following diameters on forward/reverse direction of measuring pipe of detector to allow less difference and disturbance in flow velocity and direction.

Forward direction: Min. 10D

Reverse direction: Min. 5D

Note

a. L stands for length of pipe section. D stands for diameter. Pipe section stands for the section that whole length of pipe and half length of detector are combined.

b. Contracting section is included as pipe section.

c. Consult with Toshiba's Sales Dept. or agency when you cannot install pipe section in regulated length.

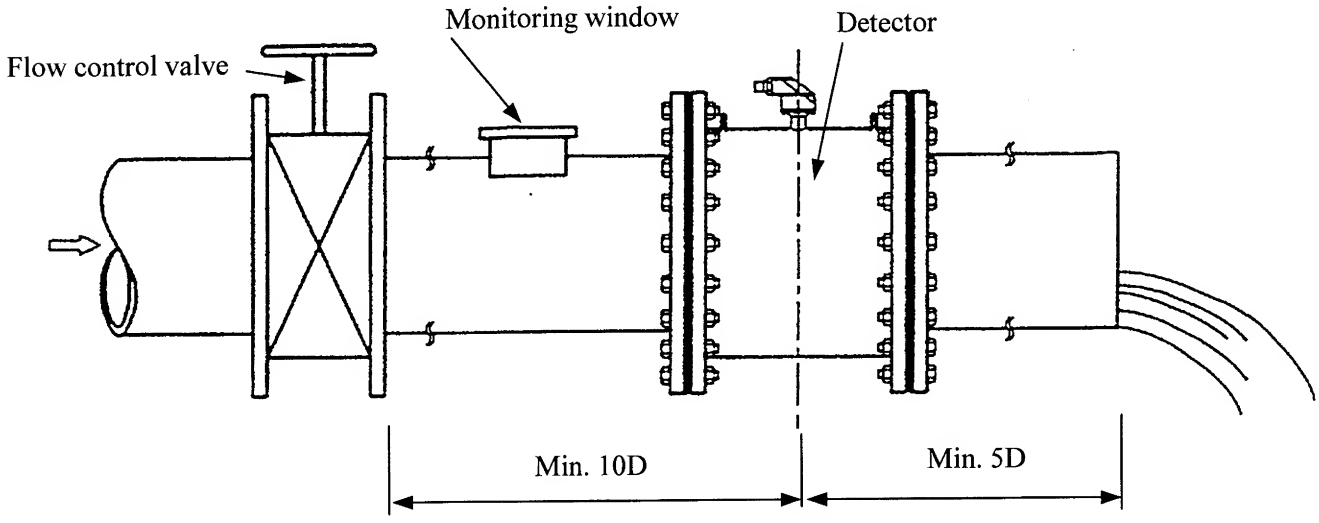


Figure 4.3 Installing pipe section on forward/reverse direction of detector

(2) Locate electrode of detector exactly under the pipe.

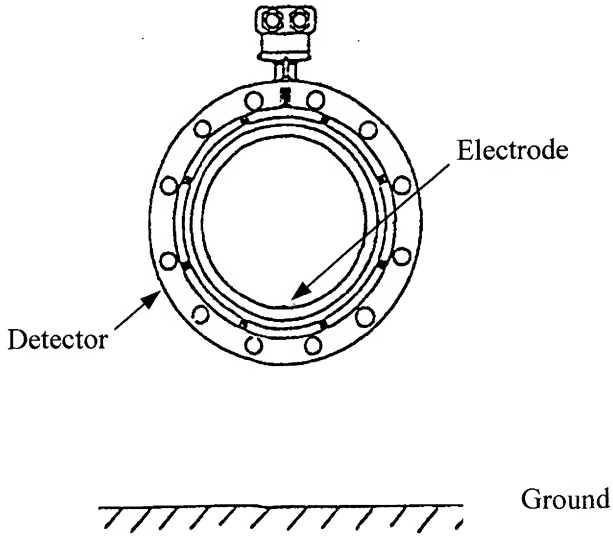


Figure 4.4 Location of detector and electrode

(3) Flow direction is indicated by arrow displayed on detector. Install detector on that direction. When fluid flows against the arrow direction, it results as follow:

LCD display: Momentary flow rate: Displayed in minus value.
Integrated flow rate: None
External output: Electric current: 4mA
Integrated pulse output: None
(Refer to "9.3 Multi-range" for setting detector into multi-range)

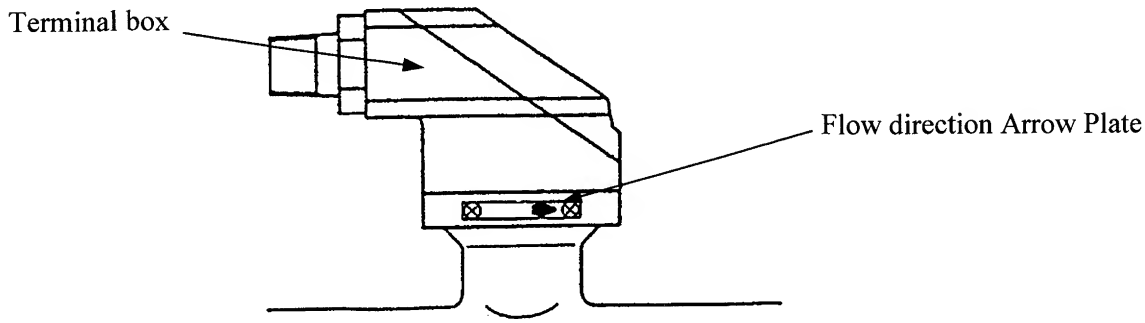


Figure 4.5 Arrow board in detector

(4) Keep flow level of measuring pipe higher than regular level.
For diameter from 150 to 300mm: Min. 30mm
For diameter from 350 to 600mm: More than 10% of diameter

Note: Flow level lower than regular level may cause exposure of electrode on bottom of detector and unstable flow to result significant difference in flow rate.

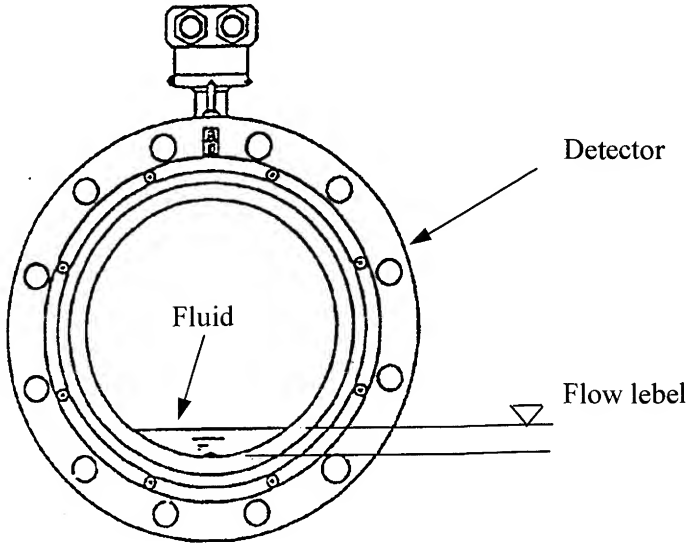


Figure 4.6 Adjust flow level

4.3 Converter Installation

Installation sites for converter are wall, panel and pipe stand.

Install converter where its front cover is located vertically and cable grounds are located below. Figure 4.7 shows installation on panel and wall and Figure 4.8 shows installation on pipe stand.

Confirm that bolts on cover are tightened before moving and installation to prevent opening.

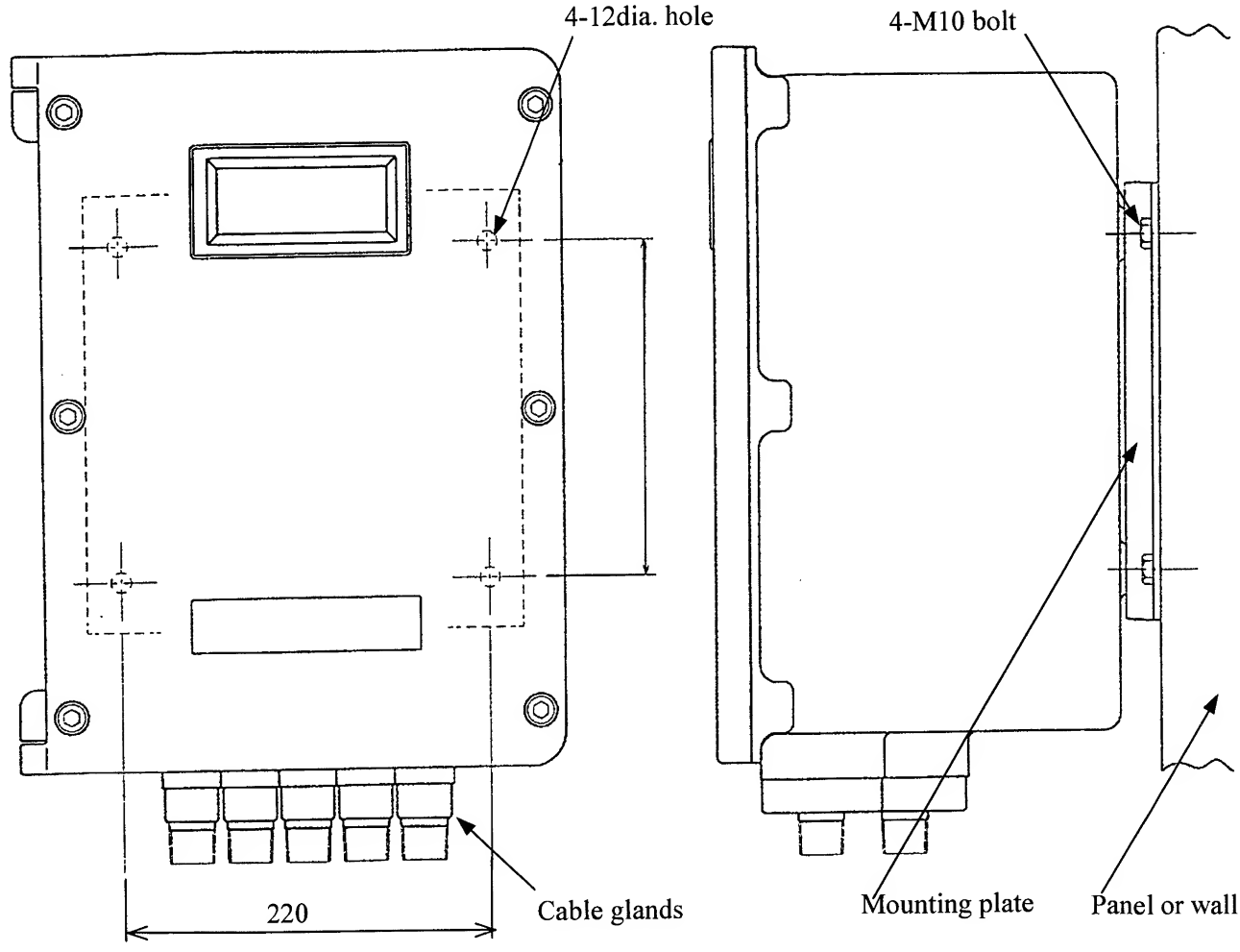


Figure 4.7 Installing converter on panel and wall

Detector

4.4 Grounding

Follow Figure 4.9 and 4.10 for grounding wire as short as possible.

Choose grounding materials which electric running area in IV wire is more than 5.5mm^2 and avoid sharing the grounding lines with other devices simultaneously. (Grounding single device is recommendable)

- For conductive connecting pipe:

Please ground terminal of detector and both ends of pipe with wire. Failure in grounding may cause unstable measurement and accuracy.

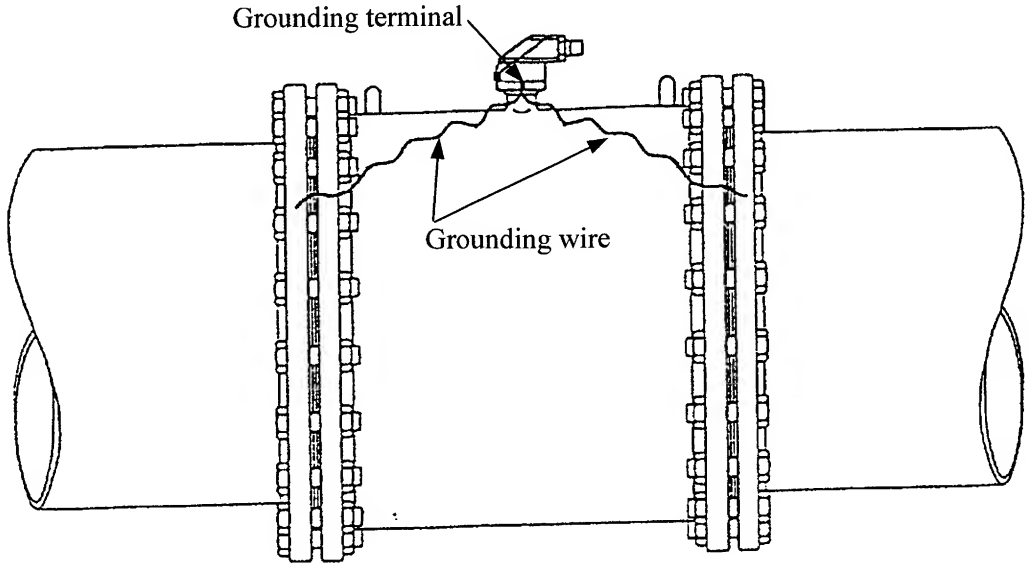


Figure 4.9

- For non-conductive connecting pipe:

Ground terminal of detector and both ends of pipe with 100 ohms or less resistance. Unstable resistance may cause unstable measurement and accuracy.

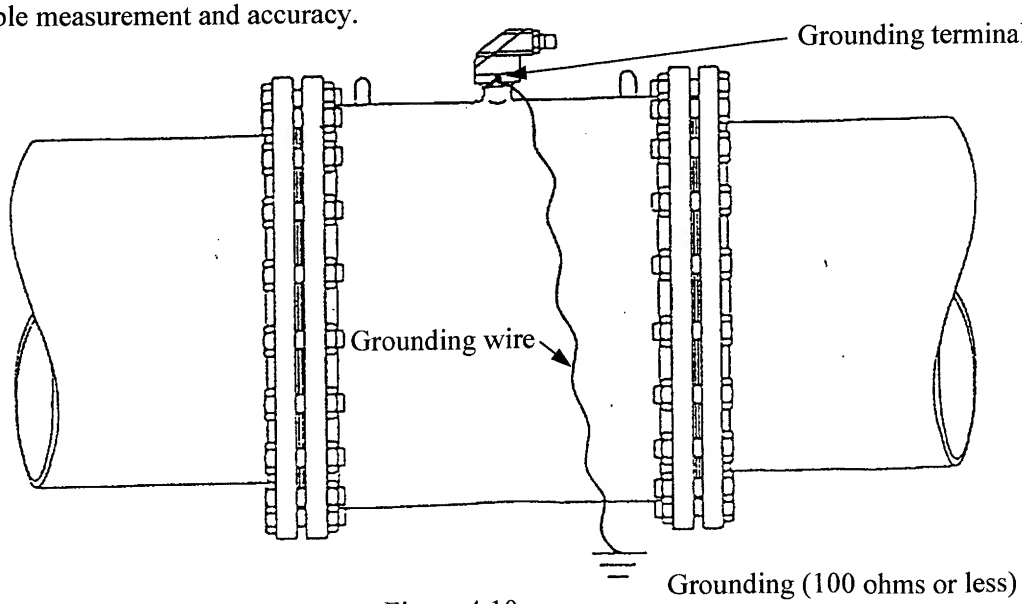


Figure 4.10

5. Wiring

⚠ CAUTION	
■ **Do not work on piping and wiring with wet hands.**  DON'T Wet hands can cause **system failure.**	**Ground the LF502 properly.**  DO Operating this product without a grounding can cause **system malfunction.**
■ **Do not modify or disassemble the LF502 unnecessarily.**  DON'T Modifying or disassembling this product can cause **electric shock, malfunction of or damage to this product.**	 The label shown left is placed near the terminal board for power input. Be alert to **electric shock.**

Flowmeter accuracy may be affected by the way wiring is executed. Proceed with wiring taking the following precautions:

(1) Select the cable runs away from electrical equipment (motors, transformers, or radio transmitters) which causes electromagnetic or electrostatic interference.

(2) Deterioration of flowmeter circuit insulation occurs if the converter interior or cable ends get wet or humidified. This in turn causes malfunction of flowmeter or noise problems. Avoid a rainy day if the flowmeter is to be installed outdoors. Even indoors, prevent water from splashing over the flowmeter. Try to finish the wiring as quickly as possible.

(3) The converter has a surge-absorbing barrier installed inside. Therefore, do not conduct a withstand voltage test for the converter. To check the insulation of the converter, use a voltage of 250 V dc or less.

5.1 Cables

Use the kind of cables shown in Table 5.1 to wire the converter.

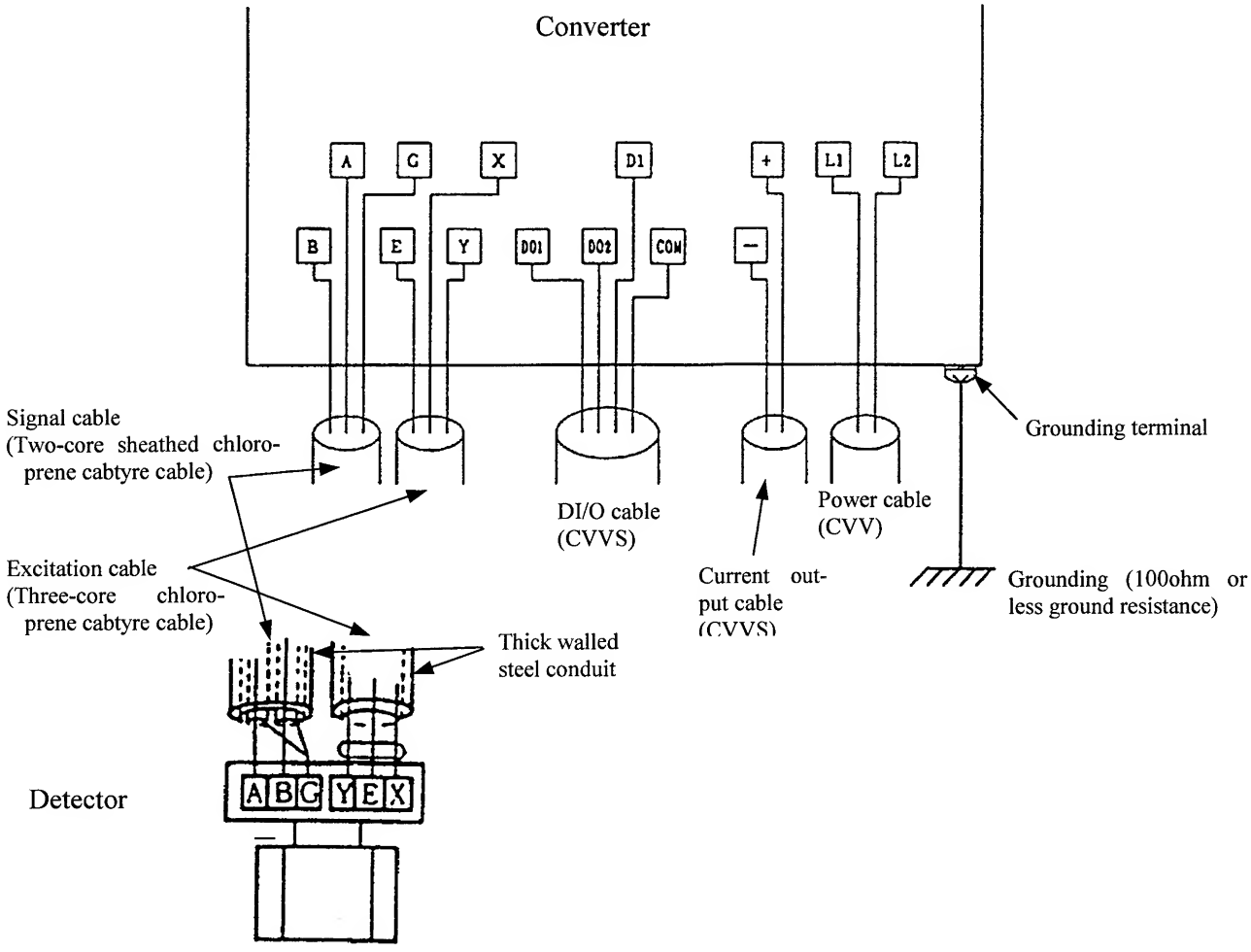
Table 5.1 Cables

Name	Cable type	Nominal cross-sectional area	Overall diameter
Input signal cable	Two-wire shielded chloroprene cabtyre cable	0.75mm²	10 to 12 mm
Excitation cable	Three-wire chloroprene cabtyre cable	2 mm² 1.25 mm²	11 to 13 mm 10 to 12 mm
Current Output cable	Two-wire shielded sheathed cable	1.5 mm²	10 to 12 mm
Power cable	Two-wire or Three-wire sheathed cable	2 mm²	11 to 13 mm
Digital I/O cable	The number of wires for the output cable depends on the system specifications. Use a shielded cable with nominal cross-sectional area of 1.5 mm² and overall diameter of 11 to 13 mm.		

5.2 External Device Connections and Grounding

The terminal block connections of the LF502 flowmeter are shown in Figure 5.1. Proceed with wiring as described in Section 5.4, "Wiring Procedure."

If power supply is specified as DC, use L1 as positive (+) and L2 as negative (–) terminals.



Notes

1) Use thick steel conduit tubes (22mm) for the signal cable and the excitation cable between the detector and the converter. The cable connection ports of the detector are R(PT)1/2 mail screws.
2) Connect the ground wire as short as possible. Avoid joining the ground wire of the flowmeter to ground wires of other instruments which have earth current through their wires.
3) To prevent a two-point grounding, ground the shielded cable of the output cables on the receiving instrument side.

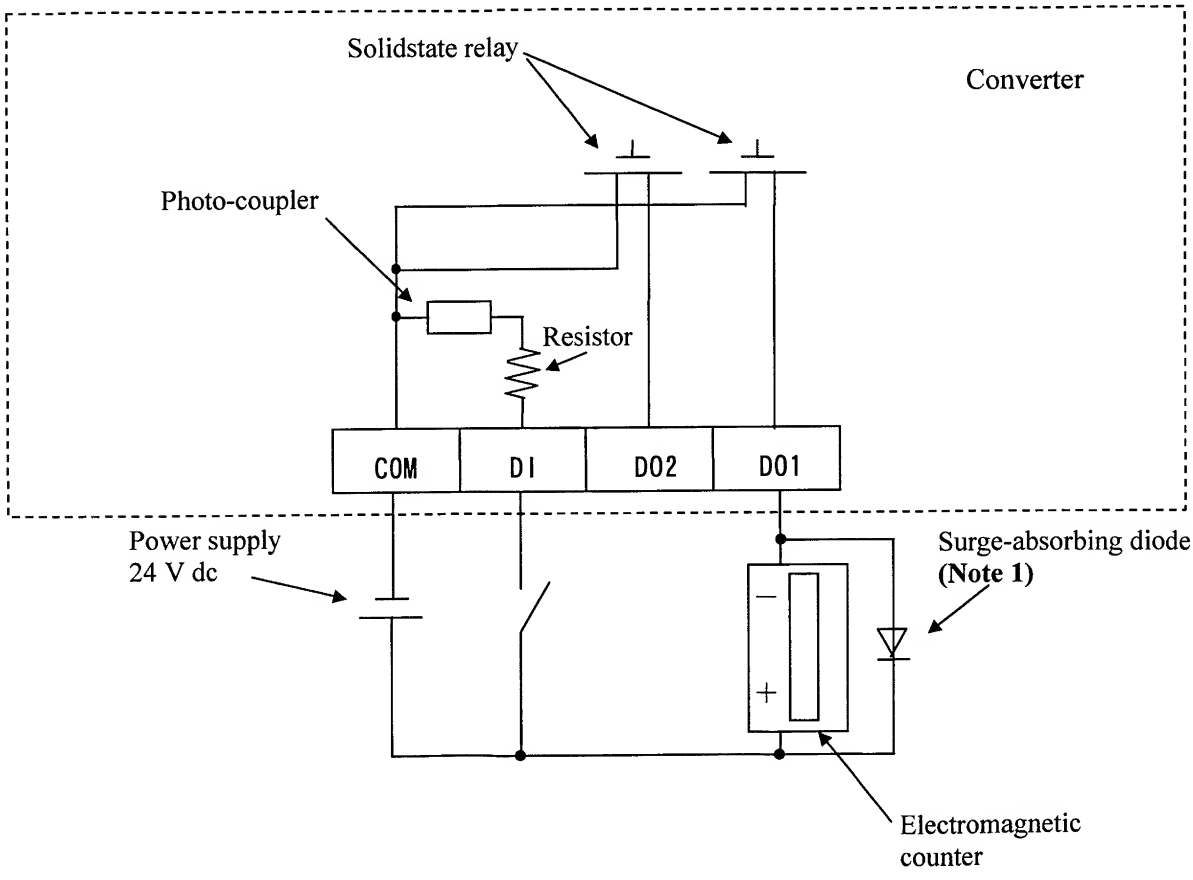
Figure 5.1 Terminal Block Connections

5.3 Digital I/O Connections

Digital I/O terminals consist of contact output terminals (standard DO1 and optional DO2), voltage signal input terminal (DI, optional), and signal common terminal (COM). Each terminal (DO1, DO2 and DI) is isolated from internal circuits. Terminal (COM) is the signal common for the other three terminals (DO1, DO2 and DI).

Functions can be assigned for each terminal with the LCD control keys (option). See Chapter 10, "Digital I/O Functions."

To connect an electromagnetic relay or counter to the contact output terminal (DO1 or DO2), put a surge-absorbing diode into the input circuit of the relay or counter. See Figure 5.3 for an example of electromagnetic counter connection.



Note 1: Use a surge-absorbing diode of the rating: current rating 1A and voltage rating 200V min.

Figure 5.3 Example of Electromagnetic Counter Connection

5.4 Wiring Procedure

Cable termination and cable connections are described below.

5.4.1 Cable Termination

⚠ CAUTION	
■ Do not conduct wiring work when **power is applied.** DON'T Wiring while power is applied can cause **electric shock.**	■ Do not work on piping and wiring **with wet hands.** DON'T Wet hands may result in **electric shock.**

Use cables as specified in Table 5.1.

■ Signal Cable

Remove each core coating for cable as shown in Figure 5.4. Next, attach the M4 insulating sleeve crimp-style terminals. Then, connect to terminal block A and B and twist the shields together. Cover with the terminal contraction tubes before attaching the crimp-style terminal and connecting to terminal block G .

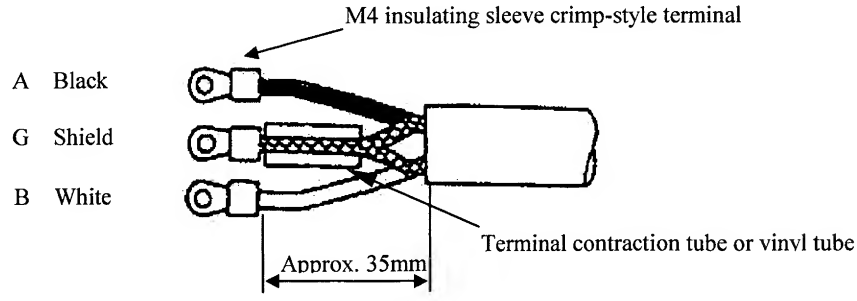


Figure5.4 Signal cable processing

Notes:

Removing core coating for cable, be careful not to scratch and not to cut off cable and shield. Untying shields from cables as shown in Figure 5.5.

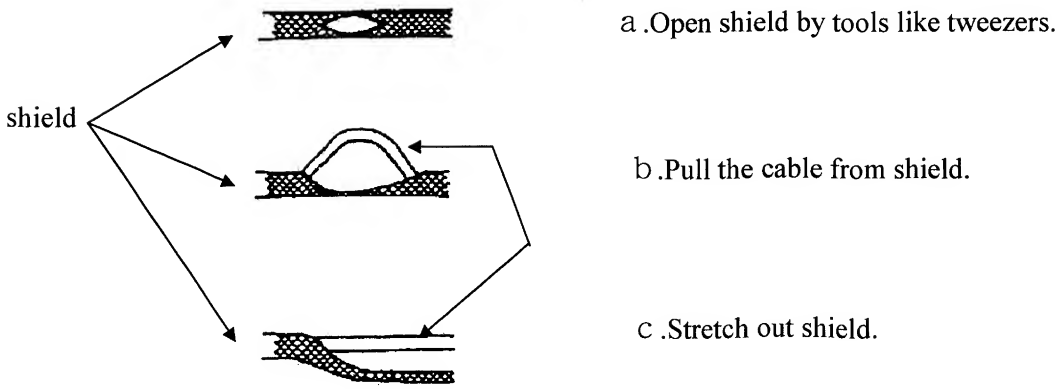


Figure5.5 Untying shields from cables

■Excitation Cable

Remove each core coating for cable as shown in Figure 5.6. Next, attach the M4 insulating sleeve crimp-style terminals. Then, connect to terminal block X and Y. Also, connect the red cable core to terminal block E

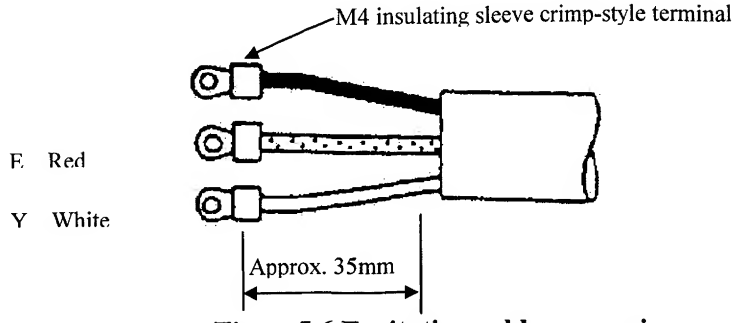


Figure5.6 Excitation cable processing

■Other Cables (Power cable and output cable)

Use cables as specified in Table 5.1. Remove the cable sheath about 70 mm from the end to expose the coated wires and then strip the wires about 10 mm. Then attach the M4 insulating sleeve crimp-style terminal to the end of each wire using a compression tool. The overall length of the wire with the terminal attached should be about 35 mm. See Figure 5.7 below.

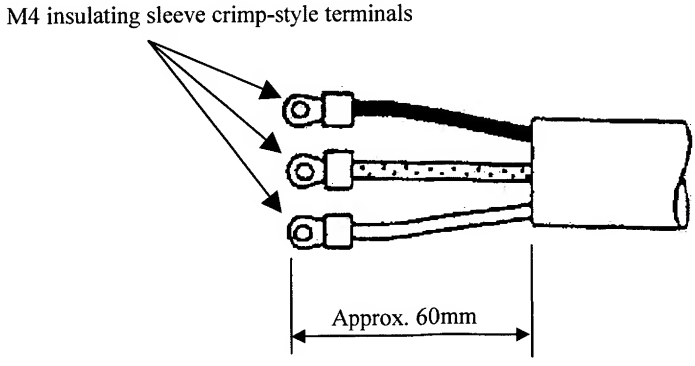


Figure 5.7 Termination of cables

5.4.2 Cabling Procedure

WARNING: All devices and wiring for detectors are processed to be ready to install at distribution. Do not remove them unless you need cable replacement.

Connect processed cable to terminal as follows:
Remove processed cable from cable gland and lead through cable gland and packing to converter.
(Remove unnecessary blind plate)

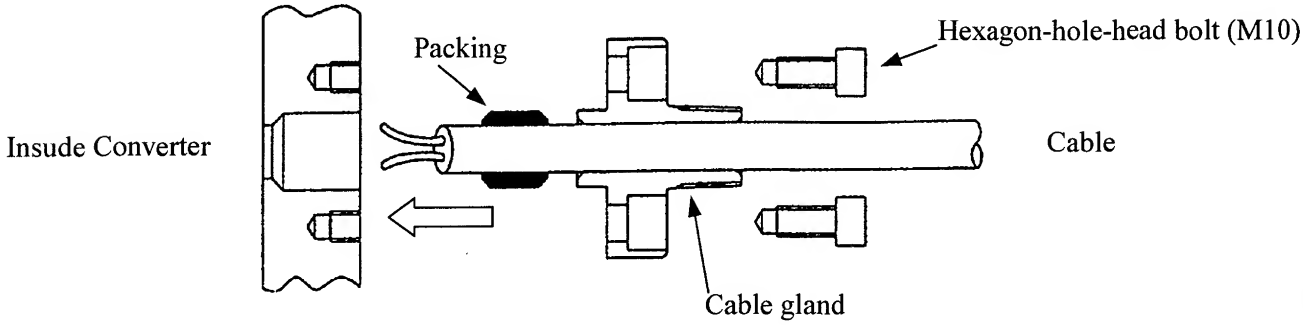


Figure 5.8 Cabling procedure

Refer to "5.2 External Cabling Procedure" for connecting cable to terminal.

* Confirm completion of connecting cable to terminal. Wrong connection may cause failure in measurement. Pull cable to confirm after connection.

⚠ CAUTION

■ Do not conduct wiring work when **power is applied.**

DON'T

Wiring while power is applied can cause **electric shock.**

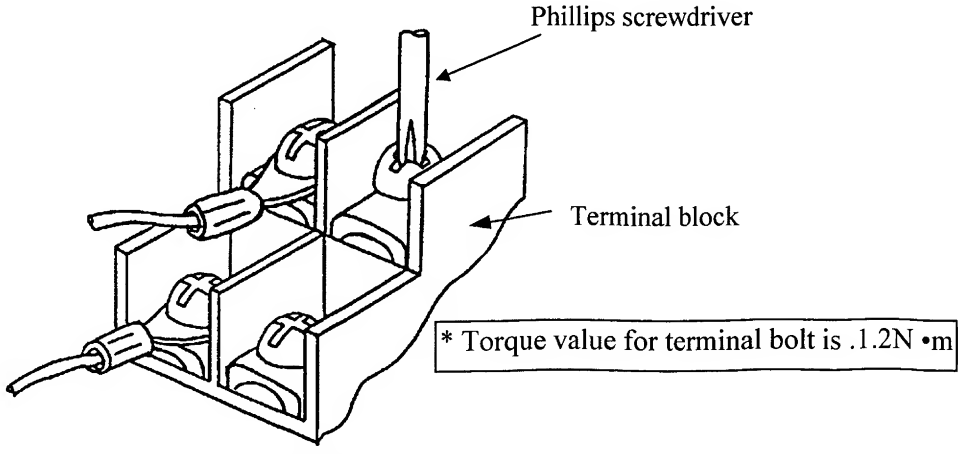


Figure 5.9 Connecting cable to terminal measurement

Stretch cable straight after connecting terminal and clamp cable ground with bolt.

Beware that the unsheathed part of cable is not touching the packing which may cause failure in maintaining air tightness.

*Appropriate torque value for clamping cap nut (Hexagon-hole-in) is from 21 to 28N •m (210 to 280kgf •cm).

- Good example

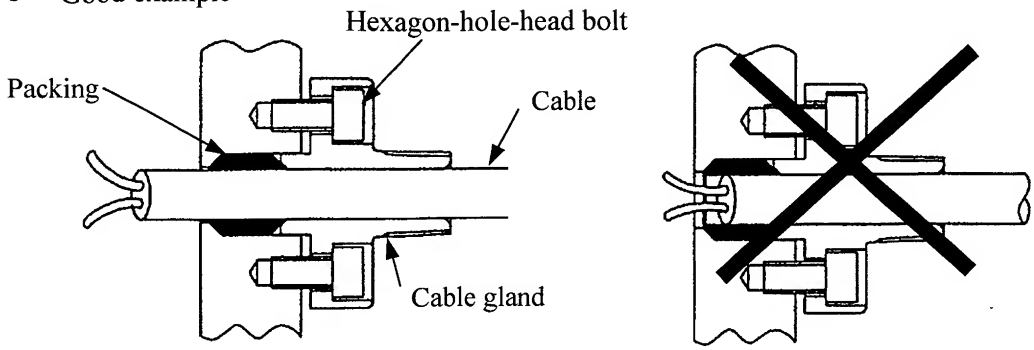
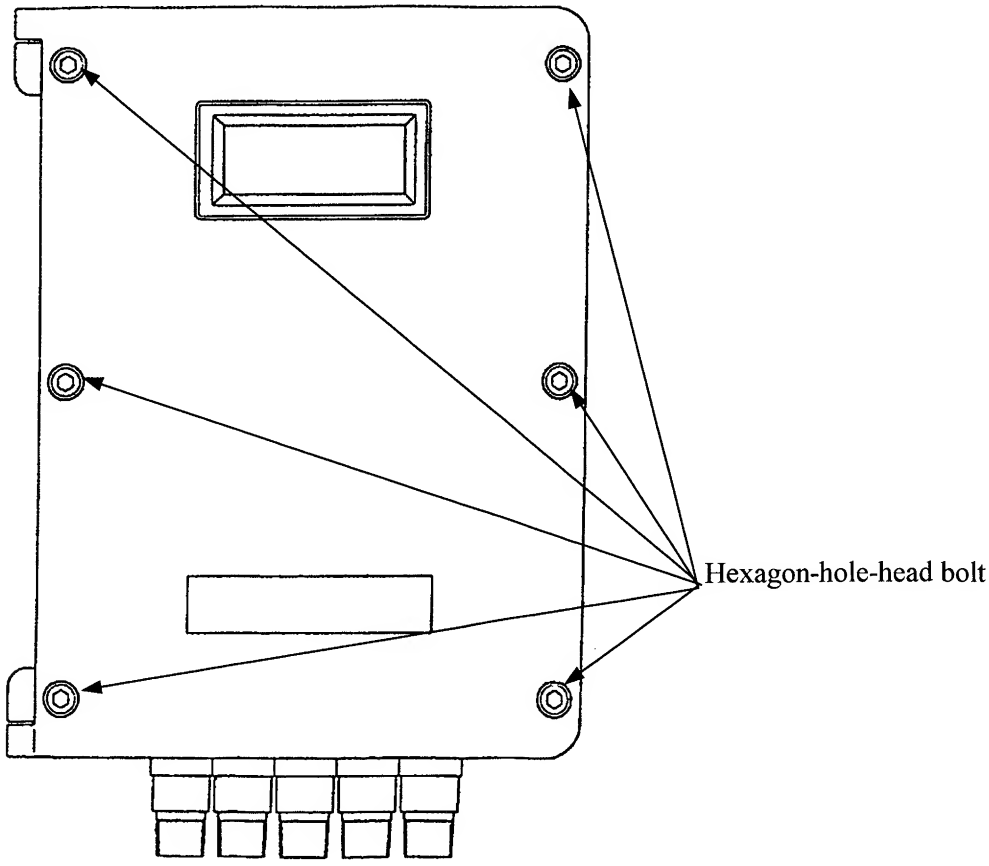


Figure 5.10 Cable clamping



*Appropriate torque value for Hexagon-hole-head bolt is from 21 to 28N •m.

Figure 5.11 Converter cover installation

6. Operation

⚠ CAUTION

■ **Do not touch the LF502 main body when high temperature fluid is being measured.**

DON'T

The fluid raises the main body temperature and can cause **burns** when touched.

6.1 Preparatory check

Follow the procedure described below to prepare before starting the flow measurement.

System Check

- Check the wiring between the converter and the detector.
- Check the wiring between the converter and related instruments.
- Make sure all the bolts of connection flanges on which the flowmeter is mounted securely tightened.
- Make sure the direction of flow arrow is in accordance with actual flow.
- Make sure the flowmeter is grounded with 100 ohm or less ground resistance.
- Make sure the converter housing covers are securely tightened.

Placing System On-Stream

- Starts fluid flowing in the measuring pipe of detector.
- Stop flowing when the fluid reaches to high level as much as possible (larger than 30% of diameter of pipe).

Supplying Electric Power

- Make sure the power supply is as specified.

Checking Converter Parameters

- Check the configuration parameter settings. Refer to Chapter 7, "LCD Display and Controls," Chapter 8, "Configuration Parameter Setting," and Chapter 11, "Communications Function."

Zero Adjustment

- Wait for 30 minutes to warm up the flowmeter. Then making sure the fluid holds still in the detector pipe, starts the zero adjustment.
  Refer to 6.2, "Zero Adjustment."

On-line measurement

After checking the items and conducting the zero adjustment as listed above, let the fluid go through the detector pipe. Output (4–20 mA dc) directly proportional to the flow rate can be obtained.

6.2 Zero Adjustment

To conduct the zero adjustment of flowmeter, the fluid in the detector pipe must be held still.
(If the fluid cannot be stopped by any means, See 7.3.1 "Zero Offset Adjustment.")
To start the zero adjustment from the measurement mode, follow the procedure described below. The zero adjustment can be conducted when the measuring unit (UNIT 1) of flowmeter is either a flow rate unit (m^3/s, l/s, etc.) or flow velocity unit (m/s, etc.). If the measuring unit (UNIT 1) is one of the totalized flow units (m^3, l, etc.) or COUNT (incremental counter mode), the zero adjustment can not be performed. Refer to 7.3.2, "Measuring Unit" for details.

Key operation	Display example	Description
CLR/ ▷	ADJUST READY 0.1 %	Press [CLR/ ▷] for about 4 seconds in the measurement mode. The display shown left appears and the flowmeter is ready for zero adjustment. **(Note 1)** (% appears regardless of measuring units selected)
CLR/ ▷	MEAS. MODE *ZERO ADJUST	Press [CLR/ ▷] again for about one second. The display as shown left appears and the zero adjustment starts.
———	00. 0% 00.00m/s	The zero adjustment will be completed in about 3 to 10 seconds. **(Note 2)** Then the system returns to the measurement mode.

Notes:
1. If the [MODE/WR] key is pressed or not a key is pressed for more than one minute under this ready-for-zero-adjustment condition, the system returns to the measurement mode.
2. Zero adjustment duration depends on the exciting current frequency (about 3 seconds for 24 Hz and about 6 seconds for 12 Hz).

To adjust the flowmeter, you have to open the converter housing cover and operate key switches.
(If the converter is specified as the enclosed operation type (option), key operations can be performed with the special magnet without opening the cover.) To operate the key switches,
See 7, "Panel Operation."

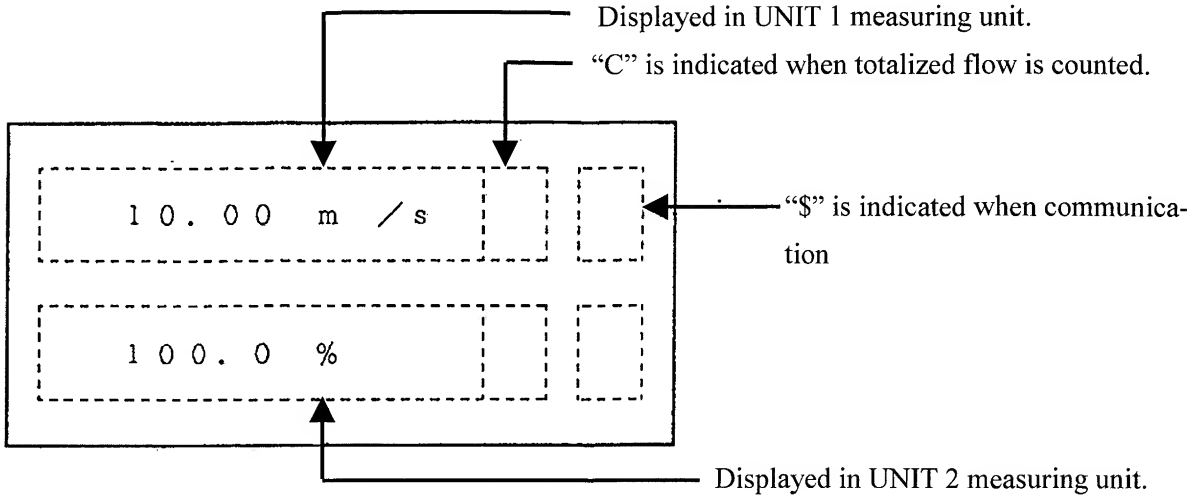
Observe the following precautions when you open the housing cover:

- Do not open the cover in the open air unprotected against rain or wind.
  If you adjust the flowmeter in the rain, it can cause electric shock or damage to the internal components of the flowmeter. And if the wind blows against the internal circuitry of the converter, the output may fluctuate and fails to indicate correct measuring values.
- Do not conduct the flowmeter adjustment when the ambient humidity is high. Opening the cover under a high humidity condition, the measuring accuracy may be deteriorated or it can cause damage to the internal components.

6.3 Measurement Mode Display

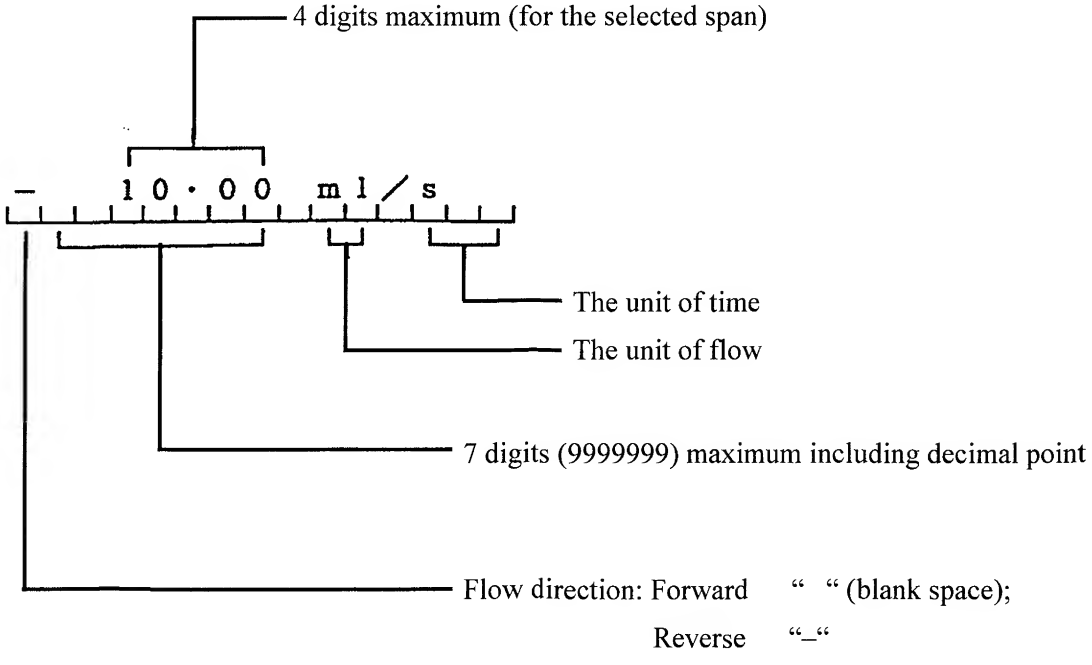
In the measurement mode, the measured data are displayed in UNIT 1 and UNIT 2 measuring units. As to measuring units, see 7.3.2, "Measuring Unit."

■ **Display Format**

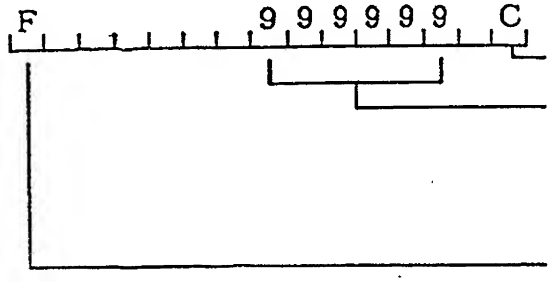


■ **Measured Value Display Format**

(1) Flow velocity



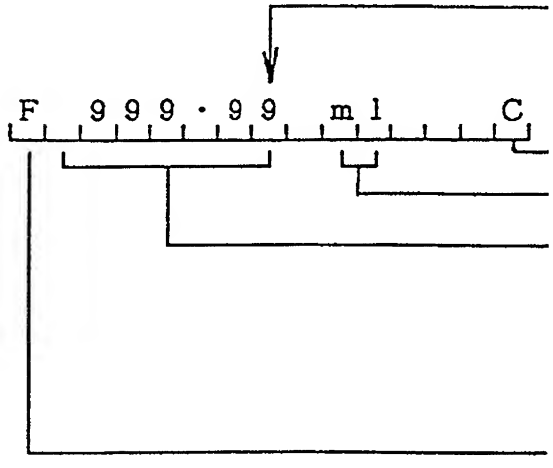
(2) Totalized flow by incremental counter



"C" is indicated when totalized flow is counted.
Increments per counting rate and wraps around after 999999.

"F" for forward and "R" for reverse direction flow will be displayed

(3) Totalized flow indicated by the measuring unit

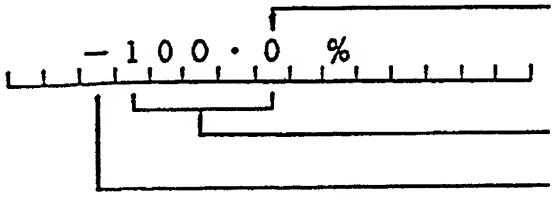


Displays down to the smallest digit of counting rate.

"C" is indicated when totalized flow is counted.
The unit of flow
7 digits (9999999) maximum including decimal point
If the totalized flow exceeds 999999, wraps around.

"F" for forward and "R" for reverse direction flow will be displayed.

(4) % display



Displayed down to 0.1 %.

Displays up to 125.0 %.
Flow direction: Forward " " (blank space);
Reverse "–"

7. Panel operation

You can select the operation mode, change the operation parameters or execute operation-specific functions using the key switches on the panel. How to operate these keys are described in this chapter.

7.1 Names and Functions of Operation Panel

The operation panel of the converter is shown in Figure 7.1.

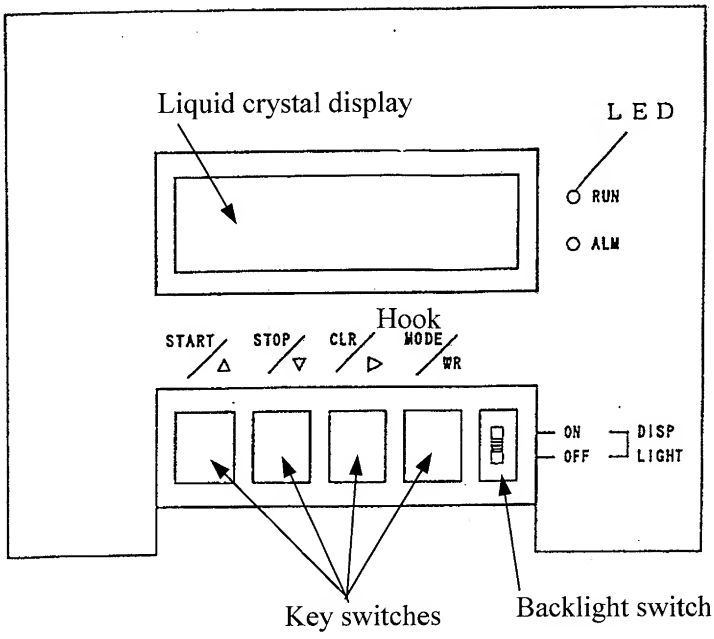


Figure 7.1 Operation panel of the converter

■ LED display

Status	RUN (green)	ALM (red)
Normal	ON	OFF
Alarm or Error occurred	ON	ON (Note)

Note: See Chapter 11, "Self-Diagnostics and Warning Functions for details.

■ Liquid crystal display

16-character × 2-line liquid crystal display. The backlight switch enables an easy-to-read display even under a dark lighting condition. Instantaneous flow rates, totalized flow values, or setting parameters can be displayed.

■ **Key switches**

Changing modes, checking or changing parameters can be done with these key switches. To operate these keys, you have to open the converter housing cover. However, if the converter is specified as the enclosed operation type (option), special type of key switches are arranged so that you can operate these keys with the magnet from outside without opening the converter cover. See Figure 7.2, "Converter cover of the enclosed operation type." To operate these keys, place the magnet vertically on top of the desired key icon.

Key switch	Basic functions
	■ Selects one of the three modes: measurement, setting or calibration. The mode does not actually change until [CLR/▷] is pressed.
START/△	■ In the setting mode: (1) when the displayed parameter is not shown with a cursor, setting items (see 7.2.2) can be selected; (2) when the parameter is shown with a cursor, the parameter can be changed.
STOP/ ▽	■ In the calibration mode, zero point, span and exciting current can be displayed.
	■ In the measurement mode, totalized flow counter can be started or stopped. **(Note)**
	■ Goes into one of the three modes being selected as described above.
CLR/ ▷	■ In the setting mode, goes into the parameter change (cursor displayed) sequence. And in that sequence moves the cursor (digit) one by one.
	■ In the calibration mode, calibrates the zero and span automatically.
	■ In the measurement mode: (1) starts the zero adjustment sequence; (2) resets the totalized flow counter to zero **(Note)**
MODE/WR	■ Starts the mode change sequence.
	■ In the setting mode, stores the selected data.

Note: To operate the totalized flow counter, set the measuring unit (UNIT 1) to one of the units appropriate for totalized flow counting. See 9.2, "Totalizer and Pulse Output for External Use."

IMPORTANT

Observe the precautions described in 6.2, "Zero Adjustment" and do not operate key switches in the open air unprotected against rain or wind or under high humidity conditions.

7.2 Basic operations

Changing the mode or parameters are the basic operations of the converter.

7.2.1 Mode Change

The converter has three operation modes: measurement, setting and calibration. The peration mode changes as shown below clockwise by pressing [START/△] or counter-clockwise by pressing [STOP/▽].

MEAS. MODE ← → SETTING MODE ← → CAL. MODE
(Measurement mode) (Setting mode) (Calibration mode)

- **Measurement mode:** measures the process flow and displays and outputs the measured process values. The flowmeter can measure the flow rates, flow velocity, or the totalized flow using the internal counter either in engineering units or as an incremental counter without a unit. The flowmeter goes into this mode when power is turned on.
- **Setting mode:** used to check or change various parameters used in the measurement mode. These parameter values are displayed while checking or changing these values but the flowmeter outputs the measured process values as in the measurement mode. See 7.3, "Checking or Changing Parameters" for details.
- **Calibration mode:** used to check the converter internal circuits. The internally generated simulation signal is used to check the measuring span and exciting current settings.

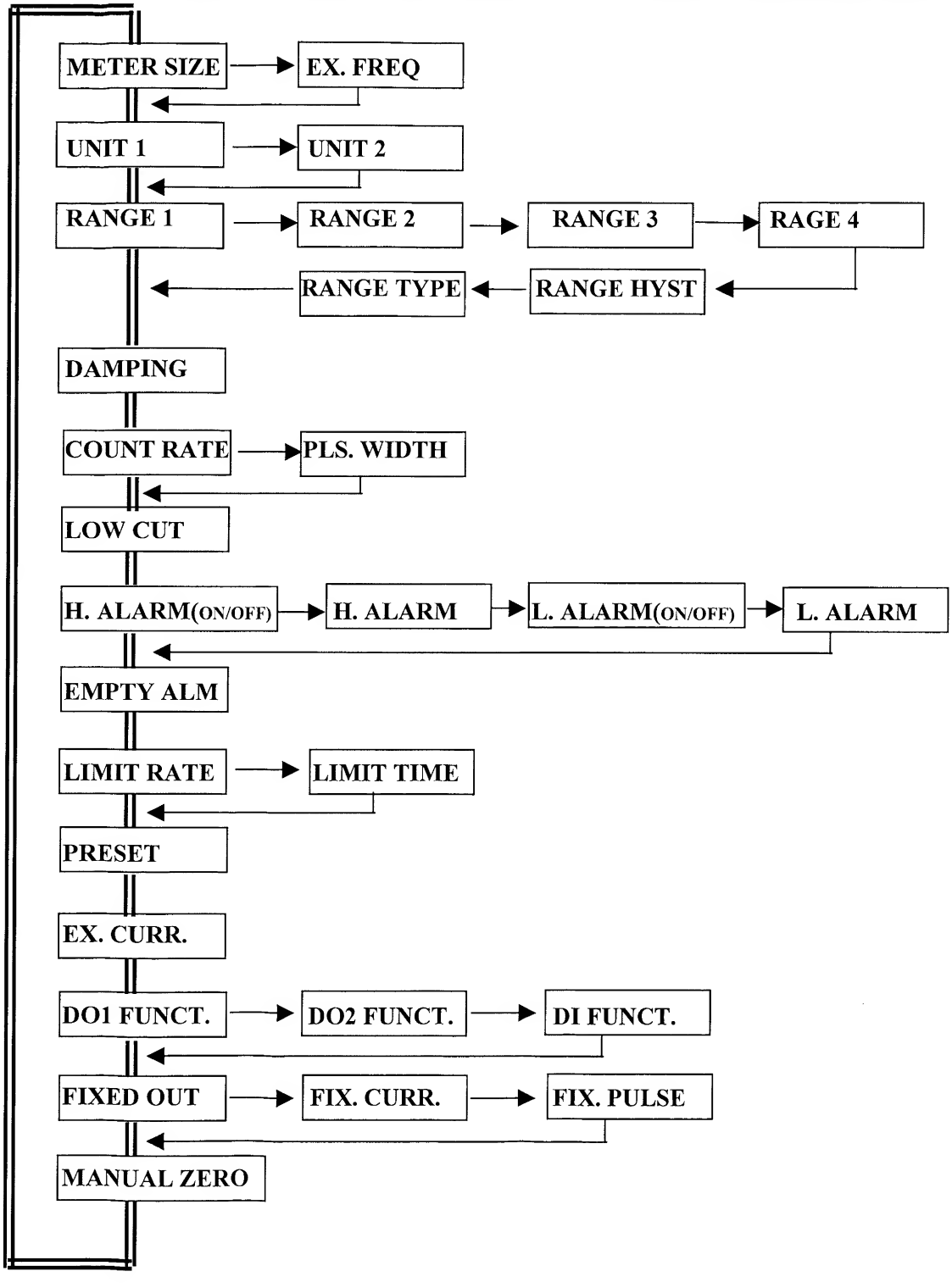
The current output of the flowmeter is in accordance with the simulation signal. The status of each digital output is held to the value just before the system turned into the calibration mode. See 8, "Calibration" for details.

To change the operation mode, proceed as follows:

Key operation	Display example	Description
MODE/WR	MEAS. MODE	Press [MODE/WR] when a cursor is not shown on the display. Then the current mode will be displayed.
START/△ STOP/▽	SETTING MODE	Select the desired mode by pressing [START/△] or [STOP/▽].
CLR/▷	SET: METER SIZE 300 mm	Goes to the selected mode. If the selected mode is the setting mode, then you have to select the desired setting item. See the following section.

7.2.2 Setting Items Selection

In the setting mode following the procedure described in 7.2.1, the setting items can be changed sequentially as shown by the dual line in the diagram below. To select the desired setting item, press [START/△] or [STOP/▽] key as many times as necessary when the displayed parameter is not shown with a cursor. The thin line in the diagram indicates sub-items. See the following sections for details about each item.



7.3 Checking or Changing Parameters

To check or change parameters, first select the desired setting item as described in 7.2. The setting items are listed below. See each section for detailed procedure.

No.	Setting item	Display example		Page
7.3.1	Meter size	SET: METER SIZE	300 mm	41
	Excitation Frequency	SET: EX. FREQ.	6 Hz	
7.3.2	Measuring unit	SET: UNIT 1	m/s	42
7.3.3	Span (range)	SET: RANGE 1	01.000 m/s	44
	Hysteresis	SET: RANGE HYST	1: SINGLE	
	Range Type	SET: RANGE TYPE	05.0 %	
7.3.4	Damping Constant	SET: DAMPING	05.0 SEC	49
7.3.5	Counting rate	SET: COUNT RATE	1.00E–1	50
	Pulse Width	SET: PLS. EIDTH	020 msec	
7.3.6	Low Cutoff	SET: LOW CUT	05.0 %	52
7.3.7	High/Low Alarm	SET: H. ALARM	ON	53
	Alarm Limit Value	SET: H. ALARM	+100.0 %	
7.3.8	Empty Pipe Alarm	SET: EMPTY ALM	ON	55
7.3.9	Rate-Of-Change Limit	SET: LIMIT RATE	05.0 %	56
	Control Limit Time	SET: LIMIT TIME	01 SEC	
7.3.10	Preset Count	SET: PRESET	009000	58
7.3.11	Exciting Current	SET: EX. CURR.	0.2100 A	59
7.3.12	Digital I/O	SET: DO1 FUNC.	1: H ALM	60
7.3.13	Fixed-Value Output	SET: FIXED OUT	OFF	62
7.3.14	Zero Offset Adjustment	SET: MANUAL ZERO	–000.6 %	64

7.3.1 Meter Size and Excitation Frequency

Proceed as follows to check or change the meter size of the detector and excitation frequency.

■ **To check the meter size and excitation frequency:**

Key operation	Display example	Description
START/△ STOP/▽	SET: METER SIZE 150 mm	Select **METER SIZE** from among the setting items by pressing [START/△] or [STOP/▽] as many times as necessary. Then the current meter size will be displayed
CLR/▷	SET: METER SIZE 150 mm	Pressing [CLR/▷], the cursor appears.
MODE/WR	SET: EX. FREQ. 6 Hz	Pressing [MODE/WR], the current excitation frequency appears. Pressing [MODE/WR] again, the system returns to the setting items selection sequence.

IMPORTANT
Meter size is factory set when shipped. Do not change the meter size and the excitation frequency unless it differs from the specified value.

7.3.2 Measuring Unit

You can select one of the 16 engineering units listed below as a measuring unit.

- **Flow velocity:** m/s, (ft/s)
- **Flow rate:** m^3/s, m^3/min, m^3/h
  l/s, l/min, l/h
  ml/s, ml/min, ml/h
  (gal/s), (gal/min), (gal/h)
- **Volumetric flow (totalized flow):** m^3, l, ml, (gal)
- **Other units:** %, COUNT (totalized flow counts without a unit), RANGE (1 to 4)

Notes

1. Units in parentheses, such as those including "gal" and "ft" are shown only when the meter size is selected in inches. They are not shown when the meter size is selected in mm.
2. If COUNT or RANGE is selected, the display is shown as follows:

COUNT: displays totalized flow counts (6 digits) without a unit.
RANGE: displays the number of range (1 to 4) in addition to the measured data.

Two measuring units (main unit: UNIT 1, sub-unit: UNIT 2) can be selected.
Proceed as follows to check or change these two measuring units.

■ **To check the measuring units:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: UNIT 1 %	Select **UNIT 1** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current main measuring unit will be displayed
CLR/ ▷	SET: UNIT 1 %	Pressing [CLR/], the cursor appears.
MODE/WR	SET: UNIT 2 m/s	Pressing [MODE/WR], the current measuring unit (sub-unit) appears. Pressing [MODE/WR] again, the system returns to the setting items selection sequence.

■ **To change the measuring units:**

The following example shows how to change the main measuring unit from % to ml/s.

Key operation	Display example	Description
START/△ STOP/▽	SET: UNIT 1 %	Select **UNIT 1** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current main measuring unit (% in this example) will be displayed
CLR/▷	SET: UNIT 1 %	Pressing [CLR/], the cursor appears.
START/△ STOP/▽	SET: UNIT 1 ml	Select "ml" as the first unit of main measuring unit by pressing [START/] or [STOP/] as many times as necessary. **(Note1)**
CLR/▷	SET: UNIT 1 ml _	Pressing [CLR/], the cursor moves to the second unit (time unit) of main measuring unit.
START/△ STOP/▽	SET: UNIT 1 ml/s	Select "s" as the second unit (time unit) of main measuring unit by pressing [START/] or [STOP/] as many times as necessary. **(Note 2)**
MODE/WR	SET: UNIT 2 %	Pressing [MODE/WR], the selected main measuring unit (ml/s in this example) will be saved. Then the system goes to the measuring unit (sub-unit) setting sequence. (If necessary, repeat the same procedure as the main measuring unit.)

Notes

1. The first unit (volumetric and other units) changes as shown below:

   → % ← → m^3 ← → l ← → ml ← → (gal)
   → RANGE ← → COUNT ← → m/s ← → (ft/s)

   Units in parentheses, such as those including "gal" and "ft" are shown only when the meter size is selected in inches. They are not shown when the meter size is selected in mm.

2. The second unit (time unit) changes as shown below:

   → s ← → min ← → h ← → _ ←

After saving (or checking) the measuring sub-unit, the system returns to the setting items selection sequence.

7.3.3 Span (range)

You can set the following constants in this setting item:

1. Span
2. Unit of span (can be changed only in range 1)
3. Range type
4. Hysteresis

(1) Span (range)

- Span can be set and displayed as follows for flow velocity and flow rates:
  - Flow velocity: 01.000 m/s (three digits after the decimal point)
  - Flow rate: 2.83E+3 m^3/H (three digits and exponential)
- Valid range of span is 0.1 m/s to 10 m/s in terms of flow velocity.
  If you try to set the span outside of this range, one of the following messages appears:
  * H. OVER SPEC. (if the set value exceeds 10 m/s)
  * L. OVER SPEC. (if the set value is less than 0.1 m/s)
  Try again to set the span within the specified range.
- When multiple ranges are used, the following must be observed:
  - Range 1 > Range 2 > Range 3 > Range 4 (unidirectional flow, multiple ranges)
  - Rage 1 > Range 2, Range 3 > Range 4 (bidirectional flows, multiple ranges)
  If you try to set the ranges not conforming to the above, the following message appears:
  * MULTI RNG ERR
  Try again to set the ranges as specified above.
- Totalized flow counting rate
  If you have changed the span while the counting rate is set for totalization, the counting rate for 100% output may have exceeded the maximum counting capacity. In the event like this, the following message appears and the system goes to the counting rate setting sequence.
  * H. OVER C RATE or L. OVER C RATE
  Set the counting rate for the newly set span.

(2) Unit of span

You can select one of the following 10 engineering units as a unit for the span. The unit is set for the range 1 and the same unit applies automatically to other ranges—range 2, range 3 and range 4.

- **Flow velocity:** m/s, (ft/s)
- **Flow rate:** m^3/s, m^3/min, m^3/h
  l/s, l/min, l/h
  ml/s, ml/min, ml/h
  (gal/s), (gal/min), (gal/h)

Units in parentheses, such as those including "gal" and "ft" are shown only when the meter size is selected in inches. They are not shown when the meter size is selected in mm.

If you change the unit, the new span will be automatically displayed based on the newly set unit.

(3) Range type

You can select a single range or multiple ranges. Select one from five types shown below:

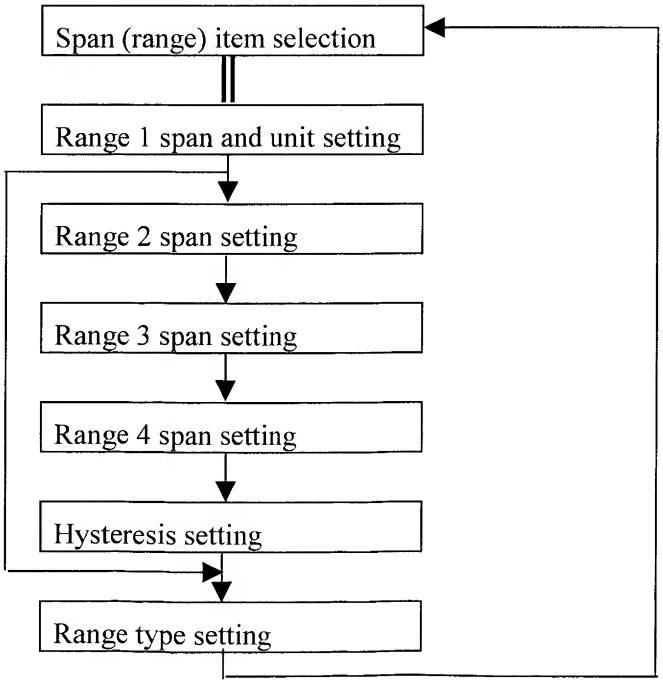
RANGE TYPE	Description
1. SINGLE	Single range
2. 4F-0R	Unidirectional flow, automatic selection of multiple ranges
3. 2F-2R	Bidirectional flows, automatic selection of multiple ranges
4. EXT.2F-0R	Unidirectional flow, multiple ranges selected by external signals
5. EXT.2F-2R	Bidirectional flows, multiple ranges selected by external signals

(4) Hysteresis

The hysteresis is the dead band used when multiple ranges are switched. The hysteresis can be set from 0 to 25% in increments of 0.1%. The hysteresis setting is needed only when automatic selection of multiple ranges is used.

[The setting sequence]

The following is the setting sequence of span (range).



If a single range is selected, range 2 to range 4 and hysteresis settings will be bypassed.

Proceed as follows to check or change each constant.

■ **To check the measuring units:**

Key operation	Display example	Description
START/△ STOP/▽	SET: RANGE 1 02.000 m/s	Select **RANGE 1** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current span for Range 1 will be displayed
CLR/▷	SET: RANGE 1 02.000 m/s	Pressing [CLR/], the cursor appears.
MODE/WR	SET: RANGE 2 01.000 m/s ↓ SET: RANGE 3 ↓ SET: RANGE 4 ↓ SET: RANGE HYST ↓ SET: RANGE TYPE	Pressing [MODE/], the span for Range 2 will be displayed. Then each time the [MODE/] is pressed, the display changes as follows: Range 3 → Range 4 → Hysteresis → Range type (If a singled range is selected as the range type, the system goes directly to Range type after Range 1.)
MODE/WR	SET: RANGE 1 02.000 m/s	Pressing [MODE/WR], the cursor disappears and the system returns to the setting items selection sequence.

■ **To change the span (range):**

The following example shows how to change the span of Range 1 from 2.0 m/s to 100 l/min.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: RANGE 1 02.000 m/s	Select **RANGE 1** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current span of Range 1 (2.0 m/s in this example) will be displayed
CLR/ ▷	SET: RANGE 1 02.000 m/s	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the position for the measuring unit.
START/△ STOP/ ▽	SET: RANGE 1 3.93E+0 l/s 2.36E+2 l/min	Select "l" as the first unit of measuring unit by pressing [START/] or [STOP/]. **(Note1)** Likewise, pressing [CLR/] to move the cursor to the second unit and select "min." **(Note 2)** (The displayed span automatically changes in accordance with the newly selected unit.)
CLR/ ▷	SET: RANGE 1 2.36E+2 l/min	Press [CLR/] as many times as necessary to move the cursor to the desired digit of span to change.
START/△ STOP/ ▽	SET: RANGE 1 1.36E+2 l/min 1.06E+2 l/min 1.00E+2 l/min	Change the value by pressing [START/] or [STOP/]. Then move the cursor to another digit by pressing [CLR/] and change the value. In this example repeat this process until the display shows "1.00E+2"(=100) l/m.
MODE/WR	SET: RANGE 2 2.65E+1 l/min	Pressing [MODE/WR], the changed span and unit will be saved. Then the system goes to RANGE 2, RANGE 3 and RANGE 4 sequentially. Follow the same procedure as RANGE 1. The measuring unit for RANGE 2 to RANGE 4 is the same as that of RANGE 1 and it cannot be changed.
MODE/WR	SET: RANGE TYPE 1:SINGLE	Pressing [MODE/WR], the changed span for Range 4 will be saved. Then the system goes to RANGE HYST setting sequence. Follow the same procedure as above.

Notes

1. The first unit of measuring unit changes as shown below:

   → m^3 ← → l ← → ml ←
   → m ← → (ft) ← → (gal) ←

   Units in parentheses (ft and gal) are shown only when the meter size is selected in inches.

2. The second character of measuring unit changes as shown below:

   → s ← → min ← → h

   However, the following first and second unit combinations cannot be selected:
   m/min, m/h, ft/min, ft/h.

■ **To change the hysteresis:**

After Rage 4 setting, the system goes to the hysteresis setting sequence. The hysteresis is set at 3% unless otherwise specified when shipped from the factory.

The following example shows how to change the hysteresis from 3% to 5%.

Key operation	Display example	Description
MODE/WR	SET: RANGE HYST 03.0 %	(The system goes to RANGE HYST setting sequence after setting the span for RANGE 4.) The current hysteresis (3.0% in this example) will be displayed
CLR/ ▷	SET: RANGE HYST 03.0 %	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: RANGE HYST 05.0 %	Change the value to "5" by pressing [START/] or [STOP/]. **(Note)** (If necessary, move the cursor to another digit by pressing [CLR/] and change the value.)
MODE/WR	SET: RANGE 1 1.00E+2 l/min	Pressing [MODE/WR], the changed hysteresis (5.0% in this example) will be saved. Then the system goes to RANGE TYPE setting sequence

Note: If you try to set the hysteresis exceeding 25.0 %, an error message "* H. OVER SPEC." appears. Try again to set the value within the specified range.

■ **To change the range type:**

After the hysteresis setting, the system goes to the range type setting sequence.

The following example shows how to change the range type from 1 to 3.

Key operation	Display example	Description
MODE/WR	SET: RANGE TYPE 1:SINGLE	(The system goes to RANGE TYPE setting sequence after setting the hysteresis.) The current range type (1 in this example) will be displayed
START/△ STOP/ ▽	SET: RANGE TYPE 3:2F-2R	Select "3" by pressing [START/] or [STOP/].
MODE/WR	SET: RANGE HYST 03.0 %	Pressing [MODE/WR], the selected range type (3 in this example) will be saved. Then the cursor disappears and the system returns to the setting items selection sequence

7.3.4 Damping Constant

The damping constant is used to moderate output fluctuations. (The larger the damping constant, the more the output will be averaged. But the response to an input change will be slower.) The damping constant can be set in the following range:

0.5 sec and 1 to 60 sec (in increments of 1 second)

(If you set the damping constant to 0.0 sec, it will work as equal to 0.1 sec damping constant.)

Proceed as follows to check or change the damping constant.

■ **To check the damping constant:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: DAMPING 20 S	Select **DAMPING** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current damping constant will be displayed

■ **To change the damping constant:**

The following example shows how to change the damping constant from 0.5 sec to 10 sec.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: DAMPING 20 S	Select **DAMPING** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current damping constant (0.5 S in this example) will be displayed.
CLR/ ▷	SET: DAMPING 20 S	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: DAMPING 50 S 50 S	Change the value by pressing [START/] or [STOP/]. Then move the cursor to another digit by pressing [CLR/] and change the value. In this example repeat this process until the display shows "10.0 S." **(Note)**
MODE/WR	SET: DAMPING 50 S	Pressing [MODE/WR], the changed damping constant (10.0 S in this example) will be saved. Then the cursor disappears and the system returns to the setting items selection sequence.

Note: The setting value exceeding 60 sec will be forcibly set to 60 sec.

7.3.5 Counting Rate (pulse rate)

When the totalized flow counter is used to measure the volumetric flow, per-count (pulse) value is the counting rate. The counting rate is set using three digits and exponential quotient.

For example, $0.123\ m^3$ ($1.23 \times 10^{-1}\ m^3$) → 1.23E-1 m^3

Proceed as follows to check or change the counting rate.

■ **To check the counting rate and pulse width:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: COUNT RATE 1.00E-2m³	Select **COUNT RATE** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current counting rate will be displayed
CLR/ ▷	SET: COUNT RATE 1.00E-2m³	Pressing [CLR/], the cursor appears.
MODE/WR	SET: PLS.WIDTH 010 ms	Pressing [MODE/WR], the current pulse width appears. Pressing [MODE/WR] again, the system returns to the setting items selection sequence.

NOTES

1. The counting rate should be set so that its rate for 100% flow rate output is within the range from 3.6 to 36000 counts/h. If you try to set the counting rate outside of this range, the error message * H. OVER SPEC or * L. OVER SPEC appears.
   Set the counting rate within the specified range.
2. The pulse width should be set to less than a half of the pulse rate for 100% flow rate output. If the pulse width is set exceeding that limit, the same error message as above appears. If the pulse width is set to 0 (zero), it will automatically be set to a half of the pulse rate for 100% flow rate output.

■ **To change the counting rate and pulse width:**

The following example shows how to change the counting rate from 0.01 m^3 to 0.9 l and the pulse width from 10 to 20 msec.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: COUNT RATE 1.00E-2m^3	Select **COUNT RATE** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current counting rate (1.00E–2m^3 = 0.01 m^3 in this example) will be displayed.
CLR/ ▷	SET: COUNT RATE 1.00E-2m^3	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to that of measuring unit.
START/△ STOP/ ▽	SET: COUNT RATE 1.00E-2l 9.00E-2l 9.00E-1l	Select "l" as the measuring unit by pressing [START/] or [STOP/]. **(Note)** Then move the cursor to the desired digit to change and change the value. In this example repeat this process until the display shows 9.00E–1l.
MODE/WR	SET: PLS.WIDTH 010 ms	Pressing [MODE/WR], the changed counting rate will be saved. Then the system goes to the pulse width setting sequence.
CLR/ ▷	SET: PLS.WIDTH 010 ms	Press [CLR/] to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: PLS.WIDTH 020 ms	Change the value to "2". by pressing [START/] or [STOP/]. (If necessary, move the cursor to another digit by pressing [CLR/] and change the value.)
MODE/WR	SET: COUNT RATE 9.00E-1l	Pressing [MODE/WR], the changed pulse width (20 msec in this example) will be saved. Then the cursor disappears and the system returns to the items selection sequence.

Note

1. The unit changes as shown below clockwise by pressing [START/] and counterclockwise by pressing [STOP/].

   → m^3 ← → l ← → ml ← → (gal) ←

The unit in parentheses (gal) is shown only when the meter size is selected in inches.

7.3.6 Low Cutoff

The low cutoff is the value set just above 0% flow rate. The flow rates below this level are treated as 0% and subsequently outputs the 0% current output. The low cutoff can be set from 0 to 10% of the span and in increments of 0.1%.

Proceed as follows to check or change the low cutoff value.

■ **To check the low cutoff value:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: LOW CUT 01.0 %	Select **LOW CUT** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current low cutoff value will be displayed

■ **To change the low cutoff value:**

The following example shows how to change the low cutoff value from 1.0 % to 3.0 %.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: LOW CUT 01.0 %	Select **LOW CUT** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current low cutoff value (1.0 % in this example) will be displayed.
CLR/ ▷	SET: LOW CUT 01.0 %	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: LOW CUT 03.0 %	Change the value to "3" by pressing [START/] or [STOP/]. **(Note)** (If necessary, move the cursor to another digit by pressing [CLR/] and change the value.)
MODE/WR	SET: LOW CUT 03.0 %	Pressing [MODE/WR], the changed low cutoff value (3.0 % in this example) will be saved. Then the cursor disappears and the system returns to the setting items selection sequence.

Note: If you try to set the low cutoff value above 10 % of the span, the error message * H. OVER SPEC appears. Set the value within the specified range.

7.3.7 High and Low Limit Alarms

The high and low limit alarms can be set to output an alarm signal when the flow rate exceeds the high or low limit set value. When this alarm occurs, H. ALARM or L. ALARM message appears and LED ALM (red) lights. This high and low limit alarm function can each be enabled or disabled in this setting item. The high and low limit values can be set from –10% to 110% of the span of the range (Range 1) in increments of 0.5%.

Proceed as follows to check or change the low cutoff value.

■ **To check the high and low limit values:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: H. ALARM ON	Select **H. ALARM** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the high limit alarm enable/disable status will be displayed.
CLR/ ▷	SET: H. ALARM ON	Pressing [CLR/], the cursor appears. (If necessary, select ON by pressing [START/] or [STOP/].)
MODE/WR	SET: H. ALARM ±100.0% ↓ SET: L. ALARM ON ↓ SET: L. ALARM ±001.0%	Pressing [MODE/WR], the high limit value will be displayed. The second time [MODE/WR] is pressed, the display changes to the low limit alarm enable/disable status. **(Note)** (If necessary, select ON by pressing [START/] or [STOP/].) The third time [MODE/WR] is pressed, the low limit value will be displayed.
MODE/WR	SET: H. ALARM ON	Pressing [MODE/WR], the cursor disappears and the system returns to the setting items selection sequence.

Note: If the high or low limit alarm enable/disable status is set to OFF, subsequent high or low limit value will not be displayed and its function described above will be disabled.

■ **To change the high and low limit values:**

The following example shows how to change the high limit value from +100 % to +105 %.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: H. ALARM ON	Select **H. ALARM** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the high limit alarm enable/disable status will be displayed.
CLR/ ▷	SET: H. ALARM ON	Pressing [CLR/], the cursor appears. (If the displayed status is OFF, select ON by pressing [START/] or [STOP/].)
MODE/WR	SET: H. ALARM +100.0%	Pressing [MODE/WR], the high limit value will be displayed.
CLR/ ▷	SET: H. ALARM +100.0%	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: H. ALARM +105.0%	Change the value to "5" by pressing [START/] or [STOP/]. **(Note)** (If necessary, move the cursor to another digit by pressing [CLR/] and change the value.)
MODE/WR	SET: L. ALARM ON	Pressing [MODE/WR], the changed high limit value (105 % in this example) will be saved. Then the system goes to the low limit alarm enable/disable status setting sequence.

Note: If you try to set the value above +110% or below –10% of the span, the error message *H. OVER SPEC or *L. OVER SPEC appears, respectively. Set the high or low limit value within the specified range.

7.3.8 Empty Pipe Alarm

The empty pipe alarm is used to notify that the detector pipe is not filled with fluid. If an empty pipe condition occurs, a message * EMPTY appears and LED ALM (red) lights.

You can enable or disable this function here.

Proceed as follows to check or change the empty pipe alarm enable/disable status.

■ **To check the empty pipe alarm enable/disable status:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: EMPTY ALM ON	Select **EMPTY ALM** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the empty pipe alarm enable/disable status will be displayed

■ **To change the empty pipe alarm enable/disable status:**

The following example shows how to disable the empty pipe alarm enable status.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: EMPTY ALM ON	Select **EMPTY ALM** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the empty pipe alarm enable/disable status will be displayed. (In this example ON will be displayed.)
CLR/ ▷	SET: EMPTY ALM ON	Pressing [CLR/], the cursor appears.
START/△ STOP/ ▽	SET: EMPTY ALM OFF	Select "OFF" by pressing [START/] or [STOP/].
MODE/WR	SET: EMPTY ALM OFF	Pressing [MODE/WR], the selected status (OFF in this example) will be saved. Then the cursor disappears and the system returns to the setting items selection sequence.

7.3.9 Rate-Of-Change Limit

The rate-of-change limit is used to eliminate high electrical noise contained in the flow rate signal. To check electrical noise, two parameters are defined: rate-of-change limit (set in percent value of the span) and control limit time (set in units of seconds). Normally the flowmeter produces the analog output signal by sampling the flow rate signal at 1/6 (or 1/24) of a second sampling rate. If the sampled value exceeds the set rate-of-change limit value—based on the averaged flow rate value up until the sampled time, the system rejects that sampled value and instead the averaged value including the rate-of-change limit value in place of the rejected sampled value will be output. However, if the limit-exceeding sampled value continues for the same flow direction for more than the preset control limit time, that data will be used as the output signal. The setting ranges for these two parameters are as follows:

- **Rate-of-change limit**

  0 to 30 %/sampling rate (in increments of 0.5 %)

  where, the sampling rate is either 1/6 or 1/24 of a second depending on the excitation frequency as shown below:

Excitation frequency	Sampling rate
6 Hz	1/6 sec
24 Hz	1/24 sec

- **Control limit time:** 0 to 20 sec (in increments of 1 second)

NOTE

If "0" is set in either of these parameters, the rate-of-change limit function is disabled.

Proceed as follows to check or change the rate-of-change limit value and the control limit time.

■ **To check the rate-of-change limit value and the control limit time:**

Key operation	Display example	Description
START/△ STOP/▽	SET: LIMIT RATE 05.0 %	Select **LIMIT RATE** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current rate-of-change limit value will be displayed
CLR/▷	SET: LIMIT RATE 05.0 %	Pressing [CLR/], the cursor appears.
MODE/WR	SET: LIMIT TIME 01 S	Pressing [MODE/WR], the control limit time appears. Pressing [MODE/WR] again, the system returns to the setting items selection sequence.

■ **To change the rate-of-change limit value and the control limit time:**

The following example shows how to change the rate-of-change limit value from 10.0 % to 15.0% and the control limit time from 3 to 5 sec.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: LIMIT RATE 10.0 %	Select **LIMIT RATE** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current rate-of-change limit value (10.0 % in this example) will be displayed.
CLR/ ▷	SET: LIMIT RATE 10.0 %	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: LIMIT RATE 15.0 %	Change the value to "5" by pressing [START/] or [STOP/]. **(Note)** (If necessary, move the cursor to another digit to change and change the value.).
MODE/WR	SET: LIMIT TIME 03 S	Pressing [MODE/WR], the changed rate-of-change limit value will be saved. Then the system goes to the control limit time setting sequence.
CLR/ ▷	SET: LIMIT TIME 03 S	Press [CLR/] to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: LIMIT TIME 05 S	Change the value to "5". by pressing [START/] or [STOP/]. **(Note)** (If necessary, move the cursor to another digit by pressing [CLR/] and change the value.)
MODE/WR	SET: LIMIT RATE 15.0 %	Pressing [MODE/WR], the changed control limit time (5 S in this example) will be saved. Then the cursor disappears and the system returns to the items selection sequence.

Note: If you try to set the value outside the valid range, the error message * H. OVER SPEC appears. Set the value within the specified range.

7.3.10 Preset Count Value

The preset count value is used to preset the totalized flow counter. The preset count value can be set from 0 to 999999.

NOTE

Totalized flow counting is effective only for the forward direction flow.

Proceed as follows to check or change the preset count value.

■ **To check the preset count value:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: PRESET 000300	Select **PRESET** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current preset count value will be displayed

■ **To change the preset count value:**

The following example shows how to change the preset count value from 500 to 1000.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: PRESET 000500	Select **PRESET** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current preset count value (500 in this example) will be displayed.
CLR/ ▷	SET: PRESET 000500	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: PRESET 001500 001000	Change the value by pressing [START/] or [STOP/]. Then move the cursor to another digit by pressing [CLR/] and change the value. In this example repeat this process until the display shows "1000."
MODE/WR	SET: PRESET 001000	Pressing [MODE/WR], the changed preset count value will be saved. Then the cursor disappears and the system returns to the setting items selection sequence.

7.3.11 Exciting Current

Proceed as follows to check or change the exciting current value.

■ **To check the exciting current value:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: EX. CURR. 0.2100A	Select **EX. CURR** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the exciting current value will be displayed

■ **To change the exciting current value:**

IMPORTANT
The exciting current value is factory set when shipped. Do not change the value unless the
value differs from what's written on the flow direction arrow tag on the detector.

The following example shows how to change the exciting current value from 0.1900A to 0.2150 A.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: EX. CURR. 0.1900A	Select **EX. CURR** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the exciting current value (0.1900 A in this example) will be displayed.
CLR/ ▷	SET: EX. CURR. 0.1900A	Pressing [CLR/], the cursor appears. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change.
START/△ STOP/ ▽	SET: EX. CURR. 0.2900A 0.2100A 0.2150A	Change the value by pressing [START/] or [STOP/]. Then move the cursor to another digit by pressing [CLR/] and change the value. In this example repeat this process until the display shows "0.2150 A." **(Note)**
MODE/WR	SET: EX. CURR. 0.2150A	Pressing [MODE/WR], the changed exciting current value will be saved. Then the cursor disappears and the system returns to the setting items selection sequence.

Note: The valid range is from 0.0500 to 0.2300 A. If you try to set the value above 0.2300 A, the error message * H. OVER SPEC appears. Set the value within the valid range.

7.3.12 Digital I/O

You can select the various digital I/O functions shown below. See Chapter 9 ,"Digital I/O Functions." for details.

■ Digital Output Functions

DO1, DO2 FUNCTION	Digital output functions
0: NO USE	Not used
1: H ALM	High limit alarm output
2: L ALM	Low limit alarm output
3: EMPTY ALM	Empty pipe alarm
4: RNG SIG 1	Multi-range output No. 1
5: RNG SIG 2	Multi-range output No. 2
6: PRESET	Preset point output
7: CONV. ALM	Converter failure alarm output
8: PULSE OUT	Pulse output **(Note)**

Note: Pulse output can be chosen only for DO1.

■ Digital Input Functions

DI FUNCTION	Digital input functions
0: NO USE	Not used
1: C STA/STP	Totalized flow counter Start/Stop
2: C RES/STA	Totalized flow counter Reset/Start
3: RANGE SW	Remote selection of multi-range
4: ZERO ADJ.	Zero adjustment start
5: FIXED OUT	Fixed-value output control

Proceed as follows to check or change the digital I/O functions.

■ **To check the digital I/O functions:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: DO1 FUNCT. 1:H ALM	Select **DO1 FUNCT.** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current DO1 function will be displayed.
CLR/ ▷	SET: DO1 FUNCT. 1:H ALM	Pressing [CLR/], the cursor appears.
MODE/WR	SET: DO2 FUNCT. 0:NO USE SET: DI FUNCT. 0:NO USE	Pressing [MODE/WR], DO2 function appears. Pressing [MODE/WR] again. DI function appears.
MODE/WR	SET: DO1 FUNCT. 1:H ALM	Pressing [MODE/WR], the cursor disappears and the system returns to the setting items selection sequence.

■ **To change the digital I/O functions:**

The following example shows how to change the DO1 function from No. 1 to No. 3.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: DO1 FUNCT. 1:H ALM	Select **DO1 FUNCT.** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current DO1 function (1: H ALM in this example) will be displayed.
CLR/ ▷	SET: DO1 FUNCT. 1:H ALM	Pressing [CLR/], the cursor appears.
START/△ STOP/ ▽	SET: DO1 FUNCT. 3:EMPTY ALM	Change the value to "3" by pressing [START/] or [STOP/].
MODE/WR	SET: DO2 FUNCT. 0:NO USE SET: DI FUNCT. 0:NO USE	Pressing [MODE/WR], the changed DO1 function (3 in this example) will be saved. (Then the system goes to DO2 and DI setting sequences.)
MODE/WR	SET: DO1 FUNCT. 3:EMPTY ALM	Pressing [MODE/WR], the cursor disappears and the system returns to the setting items selection sequence.

7.3.13 Fixed-Value Output

The fixed-value output is used to output a fixed current and a fixed pulse output independent of the flow rate signal. (The fixed pulse output is available only when DO1 is used for PULSE OUT function.) The fixed-value output can be set in the following ranges. (Current output and pulse output can be set and output at the same time.)

- **Fixed current output:** 3 to 24 mA (in increments of 0.1 mA)
- **Fixed pulse output:** 0 to 100 pps (in increments of 1 pps)

If you have disabled this function (set to OFF), you don't have to set the subsequent current and pulse output values.

When this function is enabled (set to ON), only the main measuring unit is displayed. Other data output and display conditions are as follows:

- **Current output:** User-set current output
- **Pulse output:** Pulse output with a user-set counting rate
- **Digital output:** Previous status is retained (excluding pulse output).
- **Data Display:** Instantaneous flow rates and flow velocity (no totalization)

Display example: 1.000 m/s ← Main measuring unit
* FIX.OUT 20.0 mA

This fixed-value output function does not work in the calibration mode.

Proceed as follows to check or change the enable/disable status of the fixed-value output and its output values.

■ **To check the enable/disable status of the fixed-value output and its output values:**

Key operation	Display example	Description
START/△ STOP/▽	SET: FIXED OUT ON	Select **FIXED OUT** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the fixed-value output enable/disable status will be displayed.
CLR/▷	SET: FIXED OUT ON	Pressing [CLR/], the cursor appears.
MODE/WR	SET: FIX. CURR. 20.0 mA SET: FIX. PULSE 100 pps	Pressing [MODE/WR], the fixed current output appears. Pressing [MODE/WR] again, the fixed-pulse output appears.
MODE/WR	SET: FIXED OUT ON	Pressing [MODE/WR], the cursor disappears and the system returns to the setting items selection sequence.

■ **To change the enable/disable status of the fixed-value output and its output values:**

The following example shows how to enable the fixed-value output function and to set its fixed current output to 20 mA DC.

Key operation	Display example	Description
START/△ STOP/ ▽	SET: FIXED OUT OFF	Select **FIXED OUT** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the fixed-value output enable/disable status (OFF in this example) will be displayed.
CLR/ ▷	SET: FIXED OUT OFF	Pressing [CLR/], the cursor appears.
START/△ STOP/ ▽	SET: FIXED OUT ON	Select "ON" by pressing [START/] or [STOP/].
MODE/WR	SET: FIX. CURR. 10.0 mA	Pressing [MODE/WR], the selected status (ON in this example) will be saved. Then the system goes to the fixed current output setting sequence.
START/△ STOP/ ▽	SET: FIX. CURR. 20.0 mA	Change the value to "2" by pressing [START/] or [STOP/]. **(Note)** (If necessary, move the cursor to another digit by pressing [CLR/] and change the value.)
MODE/WR	SET: FIX. PULSE 100 PPS	Pressing [MODE/WR], the changed value (20 mA in this example) will be saved. Then the system goes to the fixed pulse output setting sequence. (If necessary, change the fixed pulse output value.)
MODE/WR	SET: FIXED OUT OFF	Pressing [MODE/WR], the cursor disappears and the system returns to the setting items selection sequence.

Note: If you try to set the fixed-value output above the allowable range, the error message * H. OVER SPEC appears. Try to set the value within the specified range.

7.3.14 Zero Offset Adjustment

Zero offset can be applied to make the flowmeter outputs comparable to process values measured by other instruments. If zero adjustment described in 6.2 that requires a zero flow rate condition can be conducted, this zero offset adjustment is not needed. When the zero adjustment is completed, zero offset will be automatically cleared to zero. Zero offset can be set in the following range:

Zero offset: ±1.25 m/s (±1.25 % of 10 m/s—maximum range) maximum

Proceed as follows to check or change the zero offset value.

■ **To check the zero offset value:**

Key operation	Display example	Description
START/△ STOP/ ▽	SET: MANUAL ZERO +002.5 %	Select **MANUAL ZERO** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the current zero offset value will be displayed.

■ **To change the zero offset value:**

Calculate the zero offset value with the following equation:

Zero offset value (%) = {(actual flow rate) – (measured value)}

The zero offset value should be calculated in percent value for Range 1. See the following example.

(Example)

Measured condition	Flow rate	% in measuring span
Actual flow rate obtained from other instrument.	10.0 m^3/min	50 %
Measured value	10.5 m^3/min	52.5 %
Zero offset	————	–2.5 %

If zero offset is set to –2.5 %, the converter will output 50.0 % flow rate instead of 52.5%.

The following example shows how to change the zero offset value from +1.0% to –2.5%.

Key operation	Display example	Description
START/△ STOP/▽	SET: MANUAL ZERO +001.0 %	Select **MANUAL ZERO** from among the setting items by pressing [START/] or [STOP/] as many times as necessary. Then the zero offset value (+001.0 % in this example) will be displayed.
CLR/▷	SET: MANUAL ZERO +001.0 %	Pressing [CLR/], the cursor appears. (If necessary, press [CLR/] as many times as necessary to move the cursor to the desired digit to change.)
START/△ STOP/▽	SET: MANUAL ZERO -001.0 % -002.0 % -002.5 %	Change the sign code ("+" to "–") by pressing [START/] or [STOP/]. Then press [CLR/] as many times as necessary to move the cursor to the desired digit to change and change the value by pressing [START/] or [STOP/]. In this example repeat this process until the display shows "–002.5 %." **(Note)**
MODE/WR	SET: MANUAL ZERO -002.5 %	Pressing [MODE/WR], the changed value (–2.5 % in this example) will be saved. Then the system returns to the setting items selection sequence.

Note: If you try to set the value above +0.125 m/s or below –0.125 m/s, the error message * H. OVER SPEC or * L. OVER SPEC appears, respectively. Set the value within ±0.125 m/s.

8. Calibration

You can conduct the following in the calibration mode:

- Checks the zero and span of the converter by using a simulation signal.
- Checks the exciting current. (To change the exciting current value, see 7.3.11.)
- Calibrates the zero and span of the converter LF502 by using a simulation signal.

To change the mode to the calibration mode, see 7.2.1, "Mode Change."

IMPORTANT
To check or change the zero and span of the converter, follow the procedure described below. However, These are already checked and calibrated when shipped from the factory. Do not change these settings unless it is necessary to calibrate in the field.

■ **To check the zero, span and exciting current:**

Key operation	Display example	Description
CLR/ ▷	CAL. MODE 0.0 %	Pressing [CLR/], the system goes to the calibration mode and calculates and displays zero point using a simulation signal.
START/△ STOP/ ▽	CAL. MODE 0.0 % 100.0 % EX.CURR. 0.3000A	The display changes by pressing [START/] or [STOP/] as follows: → Zero ← → Span ← → Exciting current ←

■ **To change the zero and span of the converter:**

Follow the procedure described below to calibrate the zero point and span of the converter. However, before conducting the span calibration, make sure the following reference voltage is correct referring to Figure 8.1.

• The voltage between the check pins AG and CAL: 1.670 V

If the voltage is not correct, adjust the voltage using a trimmer VR102.

Key operation	Display example	Description
CLR/ ▷	CAL. MODE 0.1 %	Pressing [CLR/], the system goes to the calibration mode and calculates and displays zero point using a simulation signal.
CLR/ ▷	CAL. MODE * CAL. ZERO ADJ.	To start zero calibration, press [CLR/] for about 5 seconds, the display shown left appears and the zero calibration starts. The zero calibration takes about 3 to 6 seconds. **(Note)**
———	CAL. MODE 0.0 %	Newly calibrated zero point appears.
START/△ STOP/ ▽	CAL. MODE 99.9 %	Pressing [START/] or [STOP/], the current span will be displayed.
CLR/ ▷	CAL. MODE * CAL. SPAN ADJ.	To start span calibration, press [CLR/] for about 5 seconds, the display shown left appears and the span calibration starts. The span calibration takes about 10 seconds.
———	CAL. MODE 100.0 %	Newly calibrated span appears.
MODE/WR	CAL. MODE	Pressing [MODE/WR], the system returns to the mode selection sequence.

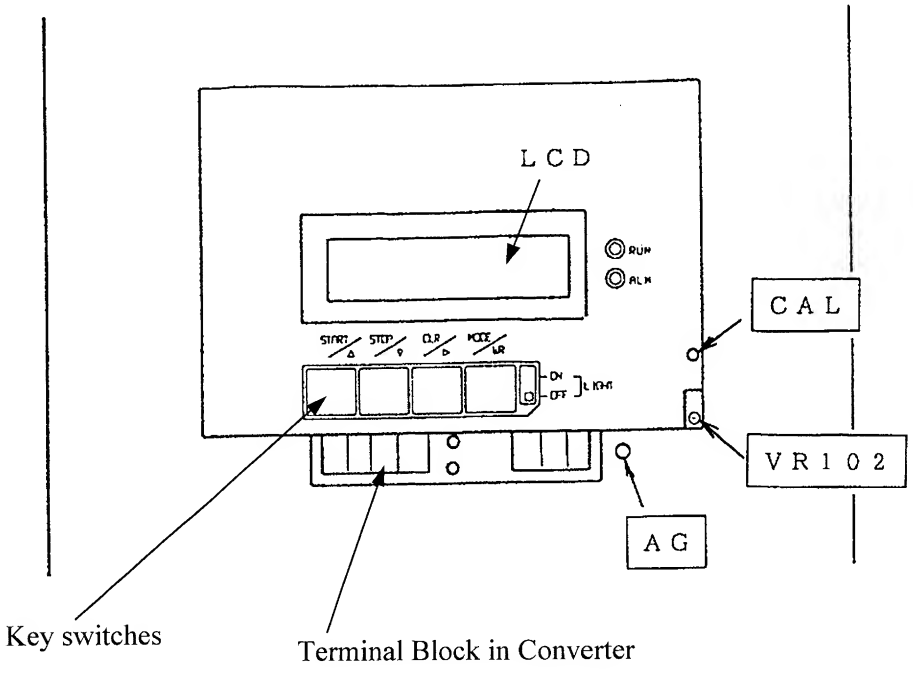


Figure 8.1 Reference voltage check pins and a trimmer

9. Digital I/O Functions

The LF502 converter has digital I/O terminals (two digital output points and one voltage input point). These terminals can be used in various ways, such as a pulse output, alarm output etc.

The digital I/O functions are shown in the following table.

Functions	Description
Totalized Flow	■ Totalizes the process flow to show its volumetric flow count. Totalized flow can be output with a scalable counting rate. ■ Totalized flow counter and pulse output can be controlled (starts, stops and resets the counter to zero) with operation key switches or by an external signal.
Multiple Ranges	■ Multiple measuring ranges can be switched according to the process flow rates either automatically or by an external signal.
Forward and Reverse flow measurements	■ Forward and reverse flows can be measured. The forward and reverse flow measurements can be used together with multiple ranges function.
High and Low Limit Alarms	■ Outputs an alarm signal when the process signal exceeds or stays below the limit value.
Empty Pipe Alarm	■ The detector pipe must be filled with fluids all the time. When it is not filled with fluids, the converter outputs an alarm signal.
Preset Totalized Flow	■ When the totalized flow counter reaches its preset count value, the converter outputs a contact output signal.
Remote Zero Adjustment	■ Zero adjustment (on-stream at zero flow rate) can be started by an external signal.
Fixed-value Output	■ Fixed current output and fixed pulse output can be used to check a process loop circuit. An external signal can also be used to control this fixed-value output.
Converter Failure Alarm	■ The converter outputs an alarm signal if an error such as memory error, excitation circuit error occurs.

9.1 Digital I/O Specifications

Digital I/O specifications for the LF502 converter are described below:

■ **Digital Output (D1, D2)**

Output type: Semiconductor contact output (no polarity)

Number of outputs: Two points

Capacity: 150 V DC, 150 mA maximum;
150 V AC (peak), 100 mA maximum

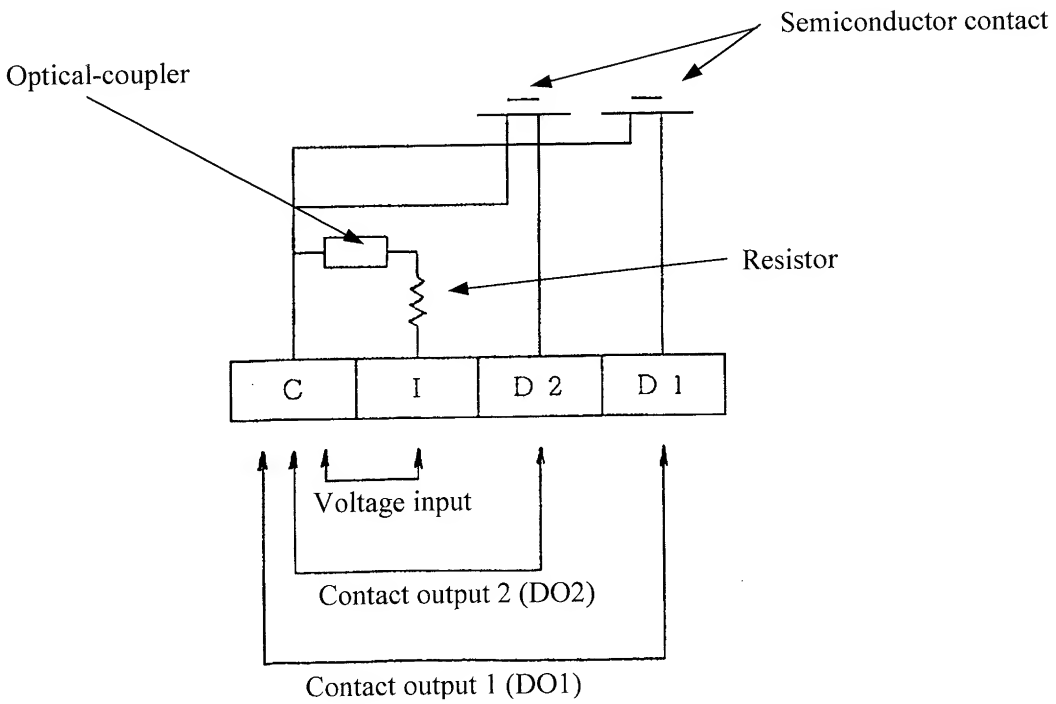
■ **Digital Input (I)**

Input signal: 20 to 30 V DC voltage signal
- High input level—20 to 30 V DC
- Low input level—2 V DC maximum

Input resistance: 2.7 kΩ

Number of inputs: One point

- Each I/O terminal can be used as a specified function terminal when selected.
- Terminal C is a signal common for the other three terminals (D1, D2 and I).
- Each terminal is isolated from the internal circuits. (The output terminals are not isolated from each other.)



9.2 Totalized Flow Counter and Pulse Output

To use the totalized flow counter or to send pulse output for external use, proceed as follows.

Counting Rate and Pulse Width settings

- Set the counting rate (flow volume per count) and the pulse width. Refer to 7.3.5, "Counting Rate." Set the pulse width in accordance with a response time of receiving instruments. If the pulse output is not used, pulse width setting is not needed.

DO setting

- Set DO1 as a pulse output contact signal. Refer to 7.3.12, "Digital I/O Functions." This is not needed if the pulse output is not used.

Measuring Unit Setting

- Select a measuring unit for UNIT 1 among units for totalized flow counts (m^3, l ,ml or COUNT).

Measurement Mode

- Set the operation mode of the system to the measurement mode. Refer to 7.3.2, "Measuring Unit."

Clear (reset) the totalizer.

- Clear (reset) the totalized flow counter by pressing [CLR/] key. If you have changed the counting rate, clear (reset) the totalized flow counter before you start the counter.

Start the totalized flow counter.

- Start the totalized flow counter by pressing [START/] key and make sure "C" is shown on the display.

Totalized Flow Counter Operation

■ Using key switches on the panel

To start, stop or clear (reset) the totalized flow counter, follow the procedure described below:

Key operation	Display example	Description
START/△	F 1 C 1.2300 m/s	Starts the totalized flow counter (pulse output). "C" for counting will be displayed and either "F" for forward or "R" for reverse flow direction will also be displayed.
STOP/ ▽	F 123 1.2300 m/s	Stops the totalized flow counter (pulse output). C" shown on the display disappears.
CLR/ ▷	F 0 1.2300 m/s	Clears (resets) the totalized flow counter (pulse output)

NOTES

1. When a bidirectional (forward and reverse) multi-range is selected, the totalized flow counter displays either forward or reverse flow counts depending on the selected flow direction range. When [CLR/] is pressed, the flow counts for both directions will be cleared to zero.
2. Non-volatile memory is used to store the totalized flow counter value. Therefore, the value will be kept in the memory even if the power is cut off.

■ Using a remote DI signal

Remote operations for the totalized flow counter and pulse output can be conducted using a DI signal. The following functions in the table can be performed. See 7.3.12, "Digital I/O" to select these functions.

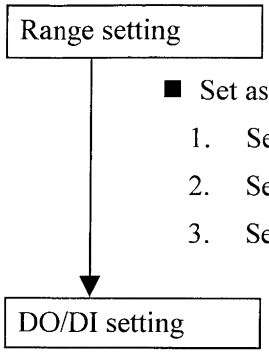
Digital input Functions	DI signal	Totalized flow counter and pulse output
Totalized flow counter START/STOP	L	Stops the counter and the pulse output.
	H	Starts the counter and the pulse output.
Totalized flow counter RESET/START	H	Stops and clears (resets) the counter.
	L	Starts the counter and the pulse output.

9.3 Multi-range Functions

Multi-range functions can be set under the setting item "RANGE TYPE." Refer to 7.3.3, "Span (Range)."
Four types of multi-range configurations are available as shown below:

(1) Automatic selection of unidirectional flow multi-range
(2) Automatic selection of bidirectional flows multi-range
(3) Remote selection of unidirectional flow multi-range with an external signal
(4) Remote selection of bidirectional flows multi-range with an external signal

Proceed as follows to use the multi-range functions.



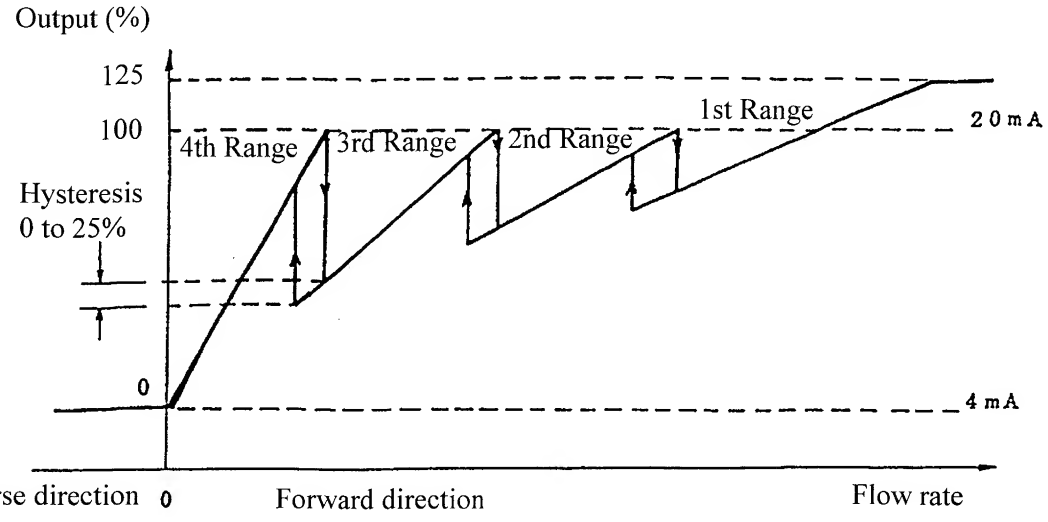
■ Set as follows referring to 7.3.3, "Span (Range),"
1. Select "RANGE TYPE."
2. Select one of multi-range configuration types (2 to 5).
3. Set the hysteresis value.

■ Set DO1 and DO2 to use them as range outputs.
Refer to 7.3.12, "Digital I/O Functions."

■ To select ranges with a remote signal, use DI as a remote signal.
Refer to 7.3.12, "Digital I/O Functions."

■ **Output performance of multi-range functions**

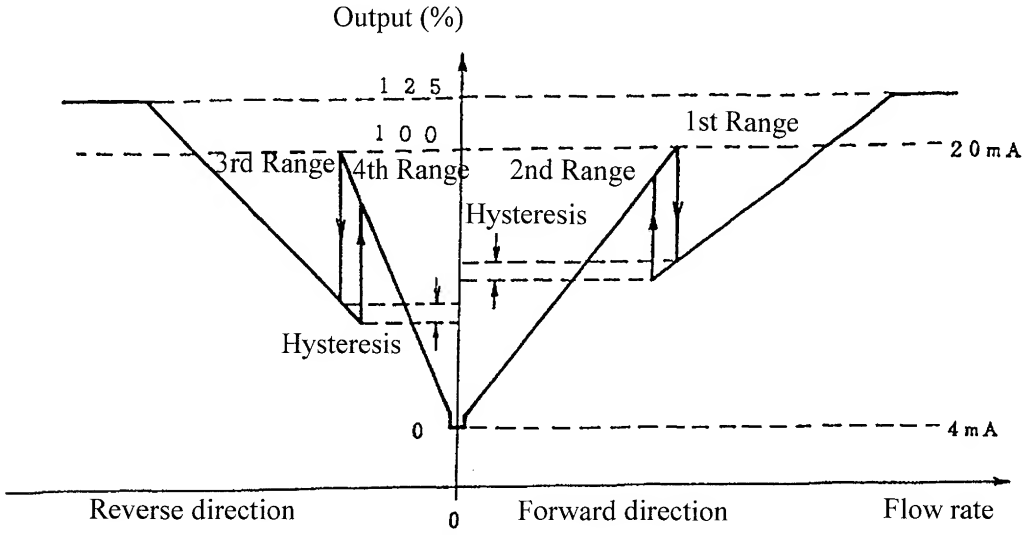
(1) Automatic selection of unidirectional flow multi-range



Range output No.1	ON	OFF	ON	OFF
Range output No.2	ON	ON	OFF	OFF

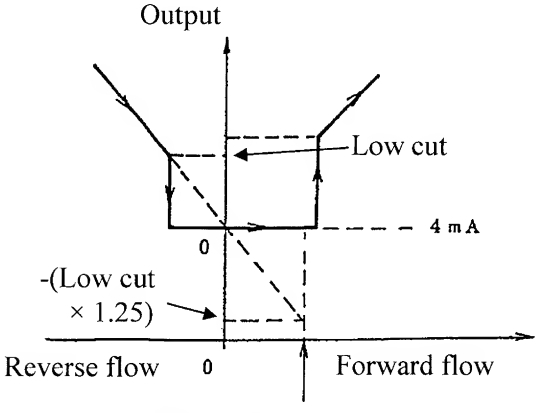
Note: The current output for opposite direction flow is 4 mA.

(2) Automatic selection of bidirectional flows multi-range



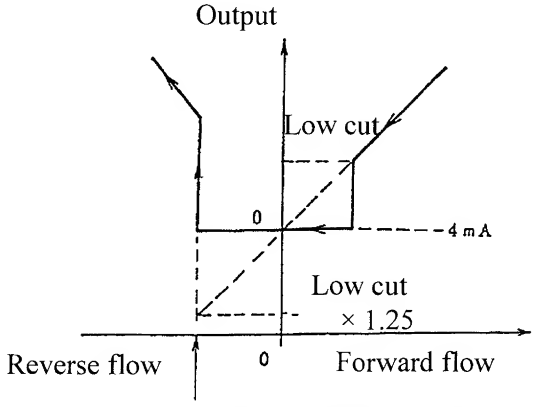
Range output No.1	ON	OFF	ON	OFF
Range output No.2	ON		OFF	

■ **Reverse to Forward direction change**



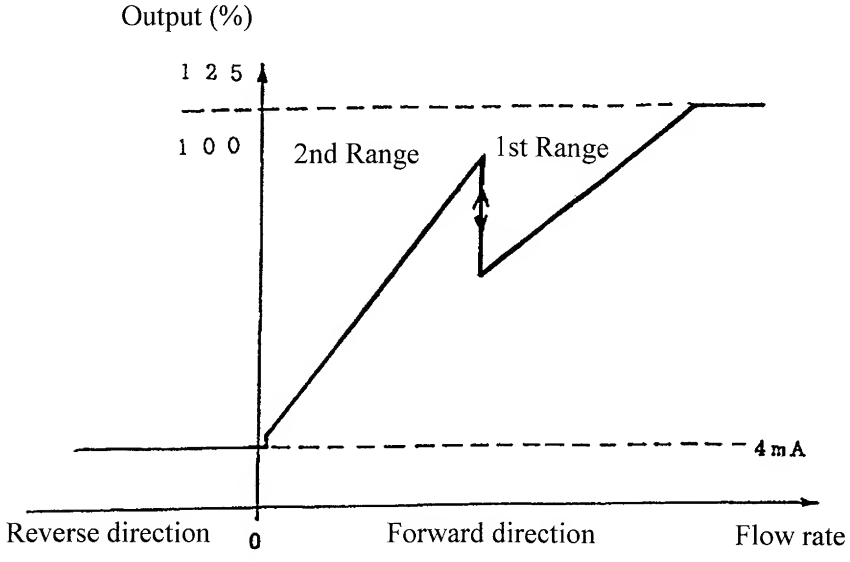
Change Reverse Range to Forward range

■ **Forward to Reverse direction change**



Change Forward Range to Reverse Range

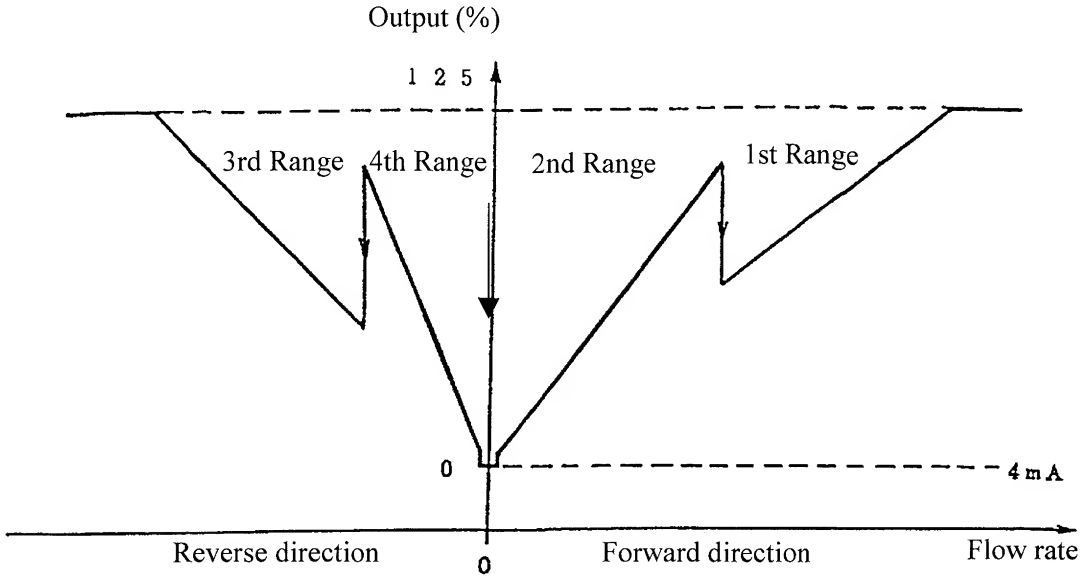
(3) Remote selection of unidirectional flows multi-range with an external signal



External signal	High level input	Low level input
Range output No.1	ON	OFF

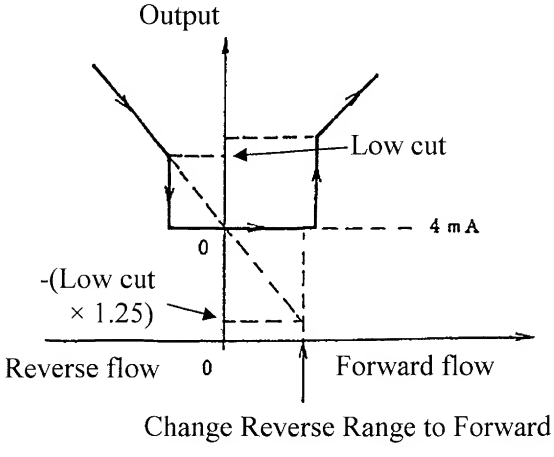
Note: The current output for opposite direction flow is 4 mA.

(4) Remote selection of bidirectional flows multi-range with an external signal



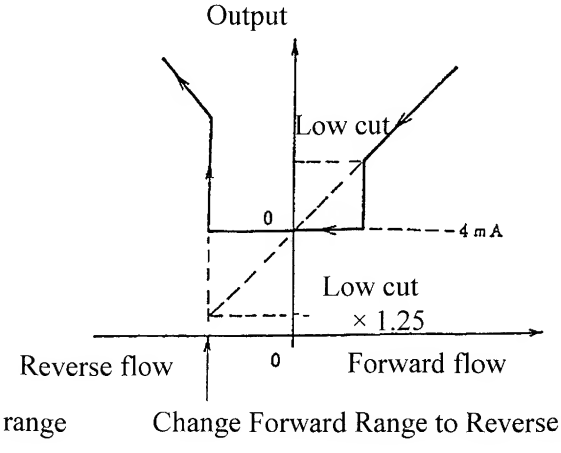
External signal	L input	H input	H input	L input
Range output No.1	O F F	O N	O N	O F F
Range output No.2	O N		O F F	

■ **Reverse to Forward direction change**



Change Reverse Range to Forward range

■ **Forward to Reverse direction change**



Change Forward Range to Reverse Range

9.4 High and Low Limit Alarms

Proceed as follows to use the high and low limit alarms:

High and Low limit value setting

■ Set the high and/or low limit alarm enable/disable status to ON and set the limit value for high and/or low alarm. See 7.3.7, "High and Low Limit Alarms."

To disable the high or low limit alarm, set its enable/disable status to OFF.

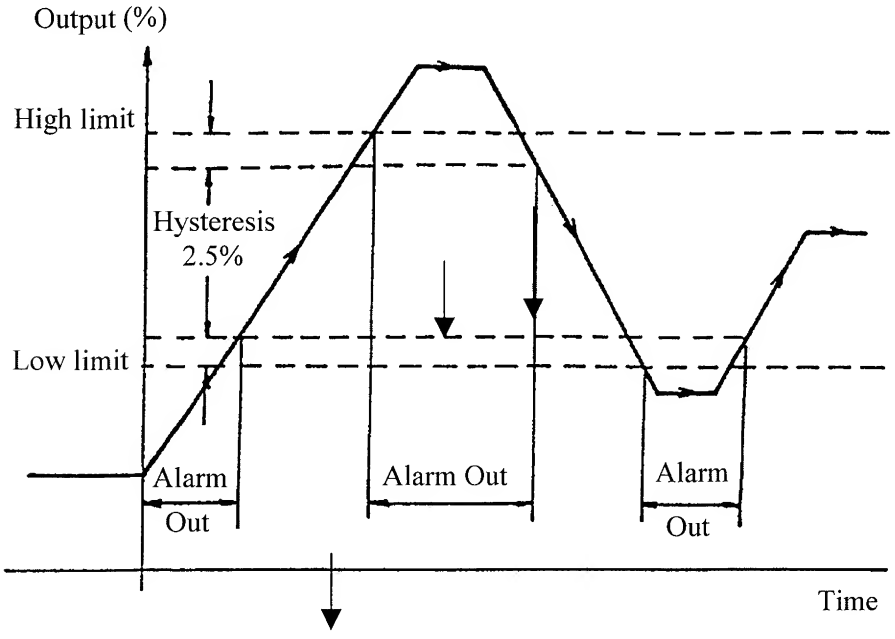
DO setting

■ Set DO1 and/or DO2 as high and/or low limit alarm outputs.

See 7.3.12, "Digital I/O Functions."

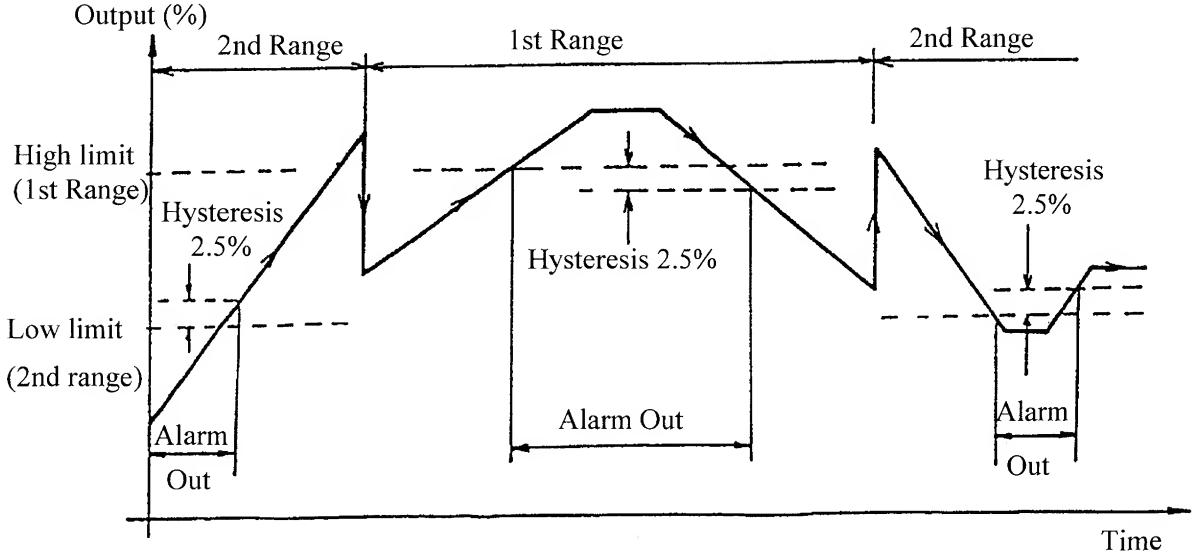
■ **High and Low Limit Alarm Output Performance**

(1) Single range performance



(2) Multi-range performance

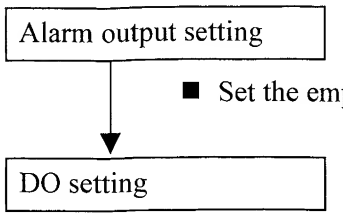
In an example shown below, a low limit alarm is set for the 2nd Range and a high limit alarm is set for the 1st Range.



Note: Alarm output is an ON signal (contact closed) when an alarm occurs.

9.5 Empty Pipe Alarm

Proceed as follows to use the empty pipe alarm output.



■ Set the empty alarm setting to ON. See 7.3.8, "Empty Pipe Alarm."

■ Set DO1 or DO2 as the empty pipe alarm output. See 7.3.12, "Digital I/O Functions." If you use the empty pipe alarm function but not an external output, this setting is not needed.

■ **Output conditions when an empty pipe alarm occurs:**

- 4–20 mA output: 4 mA
- Totalized flow counter and pulse output: Totalized flow counter and pulse output are stopped.
- Measured data display: Zero is indicated for instantaneous flow rate.
- Alarm output: ON (contact closed)

See Chapter 11, "Self-Diagnostics and Warning Functions." to use the empty pipe alarm function.

9.6 Preset Point Output

Using this preset point output function, you can output a contact signal when the totalized flow counter reaches its preset value. Proceed as follows to use this function.

Totalized flow counter setting

- Set necessary parameters and selections to use the totalized flow counter.
  See 9.2, "Totalized Flow Counter and Pulse Output."

Preset value setting

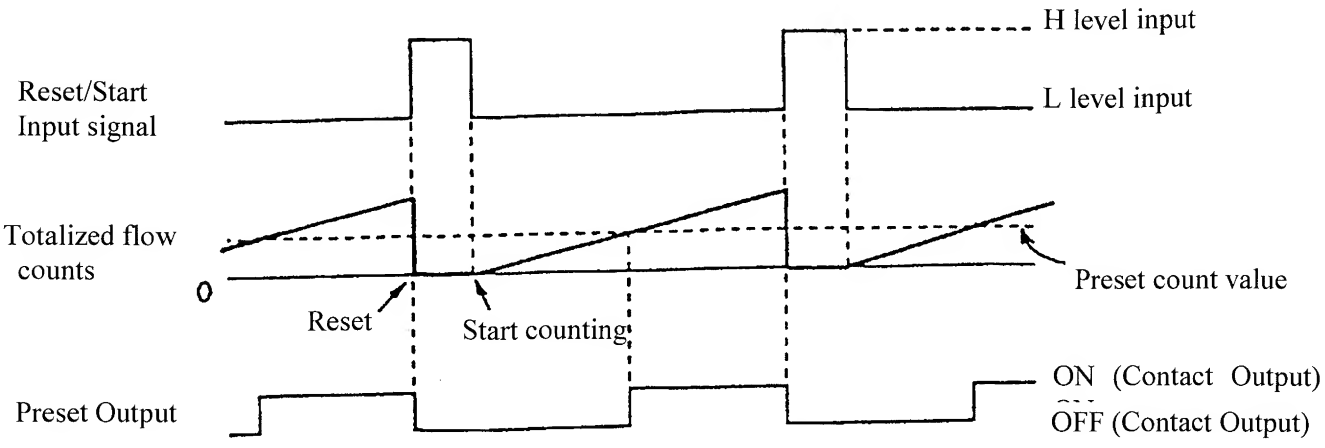
- Set the desired preset value. See 7.3.10, "Preset Count Value."

DO/DI setting

- Set DO1 or DO2 to use it as a preset point output.
  See 7.3.12, "Digital I/O Functions."
- To clear (reset) the totalized flow counter with an external signal, set DI as a Reset/Start signal. If you use the key switch on the panel to clear (reset) the totalized flow counter, this setting is not needed.

■ **Preset point output performance**

The following is an example in which the totalized flow counter is reset with an external signal.



Input/Output signal time chart

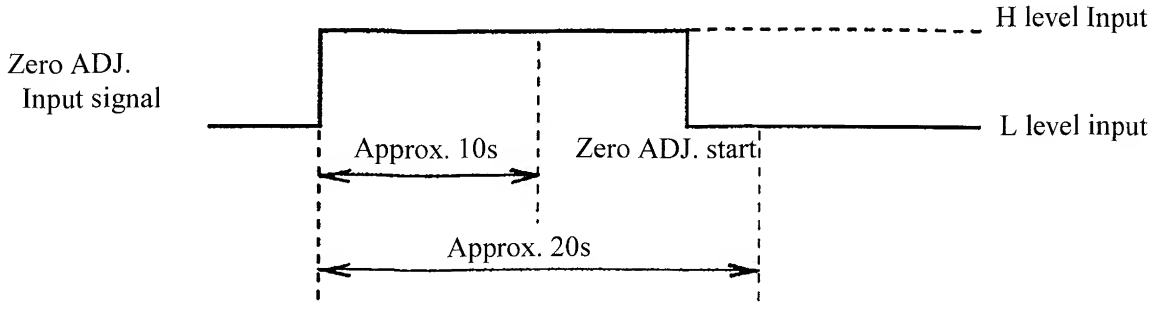
When the Reset/Start signal is in H level, the totalized flow counter is reset to zero and stops counting. When the Reset/Start signal goes to L level, the totalized flow counter starts counting.

The preset point output goes ON when the totalized flow counts reaches the preset point and the output goes OFF when the totalized flow counter is reset to zero.

9.7 Remote Zero Adjustment

On-stream zero adjustment at a zero flow rate condition can be started with an external signal. To do this, set DI as a zero adjustment start signal. See 7.3.12, "Digital I/O."

■ **Start signal requirements:**



The start signal must be set to H level first, then it must go to L level after a passage of more than 10 seconds but not more than 20 seconds as shown above. (If the signal does not go to L level within this specified period, it will be ignored.) As soon as the signal goes to L level, a zero adjustment sequence starts.

9.8 Remote Selection of Fixed Value Output

A user-specified current output and pulse output can be selected with a DI signal.

Proceed as follows to use this function:

Fixed-value setting

■ Set the fixed-value for current output and for pulse output. See 7.3.13, "Fixed-Value Output." Set the fixed-value output enable/disable status to "OFF."

If the pulse output is not used, fixed-value setting for pulse output is not needed.

DI setting

■ Set DI to use as a fixed-value output control signal. See 7.3.12, "Digital I/O Functions."

Control signal input conditions:

Control signal input	4–20 mA, pulse output
L level	Outputs the measured value.
H level	Outputs the fixed-value.

9.9 Converter Failure Alarm

When one or more of the following converter errors occur in a self-diagnostics sequence, an alarm signal can be output. To use this function, set DO1 or DO2 to use as an alarm output signal. See Chapter 11, "Self-Diagnostics and Warning Functions" for details of each alarm status.

■ Self-diagnostics errors

Self-diagnostics error (LCD display)	Error contents
ROM ERROR	ROM error
RAM ERROR	RAM error
PARAMETER FAIL	System parameter error
EX. CURR. OPEN	Excitation circuit open
EX. CURR ERROR	Excitation current error
ADC. ERROR	ADC error
REF. ERROR	Reference voltage error
CHK. CIR ERROR	Internal check circuit error
INVALID TOTAL	Invalid totalized flow counts

■ Output conditions

- Turns ON (contact closed) when an error occurs.
- Turns OFF (contact open) when power is cut off.

10. Communications Function

The LF502 converter uses HART protocol to transmit digital signals over the 4-20 mA output line. The AF100 handheld terminal is used to communicate with the LF502 using the HART protocol. You can check or change flowmeter parameters, calibrate the flowmeter or monitor the flowmeter measuring value from a remote place as far as the output line extends.

See the instruction manual of AF100 handheld terminal 6F8A???? for details.

10.1 Connections with AF100 Terminal

Connect the probe cable of AF100 terminal in parallel with the load resistance which is wired from the current output terminals (+ and –). Grab such points as pins of terminal board or junction terminal with the clip of the probe. See Figure 10.1. To connect the AF100 directly to the flowmeter, use the terminals T-CM+ and T-CM–. See Figure 10.2. These current output terminals are polarized (positive and negative) but you can connect the probe to these terminals without considering their polarity.

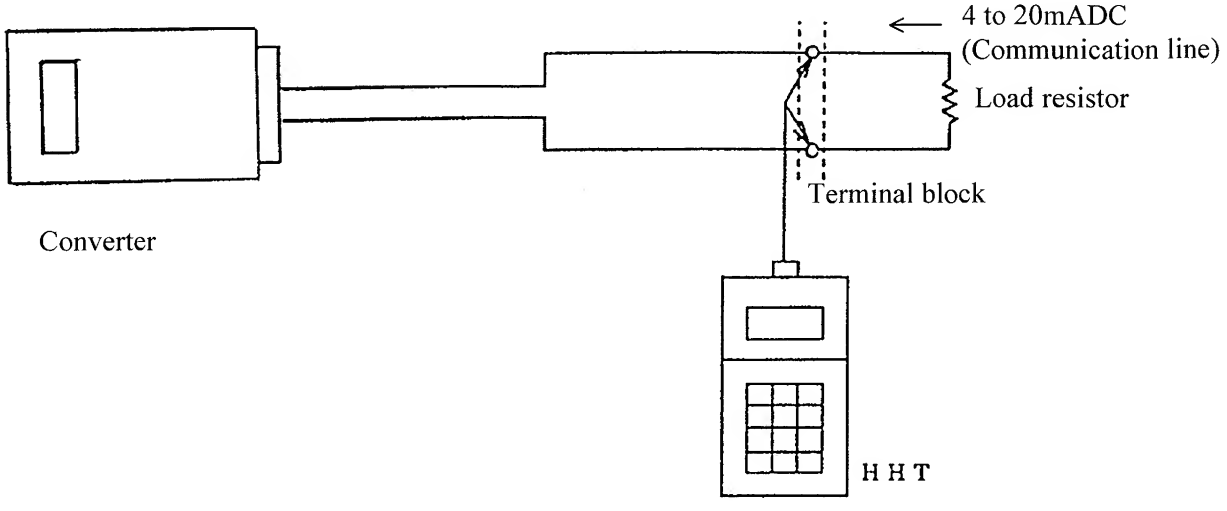


Figure 10.1 Connections to the current output line

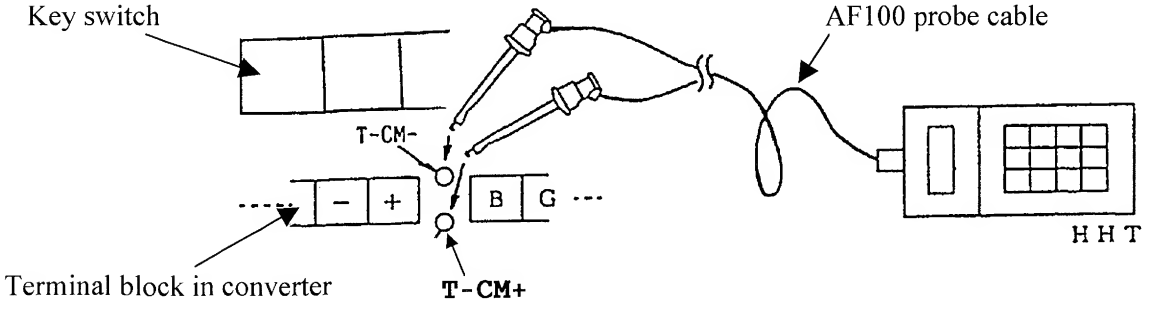
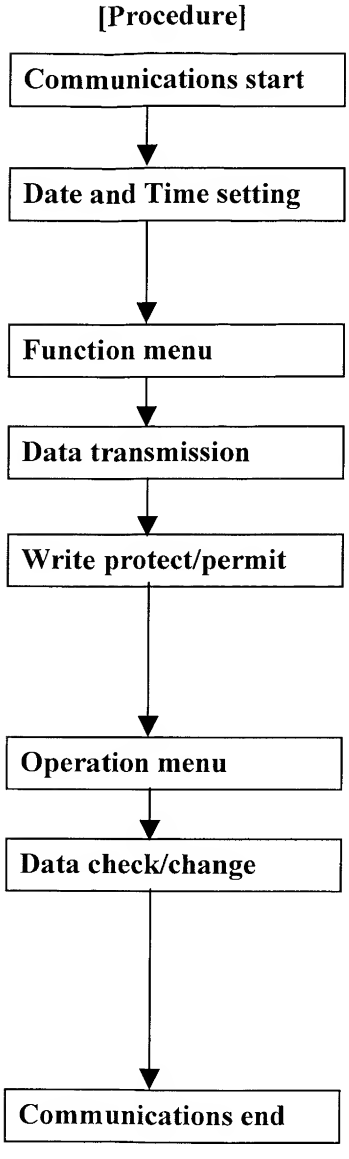


Figure 10.2 Connections to the flowmeter

10.2 Communications Procedure

Basic operations of the AF100 terminal are as follows. See the instruction manual of the AF100 terminal for details.



■ Making sure the probe cable of the AF100 is connected to the flowmeter output line, turn on the power of the AF100.

■ After the initial display, date and time setting display appears. Enter the current date and time, and press [ENTER].
Press [ENTER] only for date and time not to be changed.

■ Function menu appears. Select [F1 : Sensor].

■ Data transmission starts. Various data of flowmeter will be transmitted to the AF100.

■ Select whether you like to change/ write data to the flowmeter or simply read data from the flowmeter:
- Press [YES] and [ENTER] to change/write data; or
- Press [NO] and [ENTER] to read data only.

■ Operation menu appears. Select the desired operation item.

■ The data of the selected operation item appears.

■ To change data, press [SET], enter new data, and press [ENTER]. The new data will be transmitted to the flowmeter. The data then appears on the AF100. Make sure the data is correct.

■ When all the operations are completed, press [ESC] as many times as necessary to return to the operation menu. Then remove the AF100 probe cable from the flowmeter output line and turn off the power of the AF100.

NOTES

1. Pressing [ESC] continuously, the system goes back to "Write protect/permit."
2. Pressing [HOME] continuously, the system goes back to "Function menu."

10.3 Cautionary Notes on Communications

Observe the following notes and limitations when you use the communications function.

■ **Current output load**

Load resistance: 240 to 560 Ω (including communications line resistance)

Load capacitance: 0.22 μF maximum (including communications line capacitance)

Load inductance: 4mH maximum

■ **Wiring cable**

Use a shielded output cable as specified in Table 5.1.

■ **Interference on 4-20 mA current signal**

To communicate with the flowmeter, digital signal (amplitude 0.4 to 0.6 V—in the case of 560 Ω load resistance) with its frequency 1.2 to 2.2 kHz is superimposed on the 4-20 mA current signal. If a high-response receiving instrument is connected to the current output line, the superimposed communications signal may interfere with the instrument. To prevent this interference, put a low-pass filter with a time constant of about 100 ms to the input circuit of the receiving instrument.

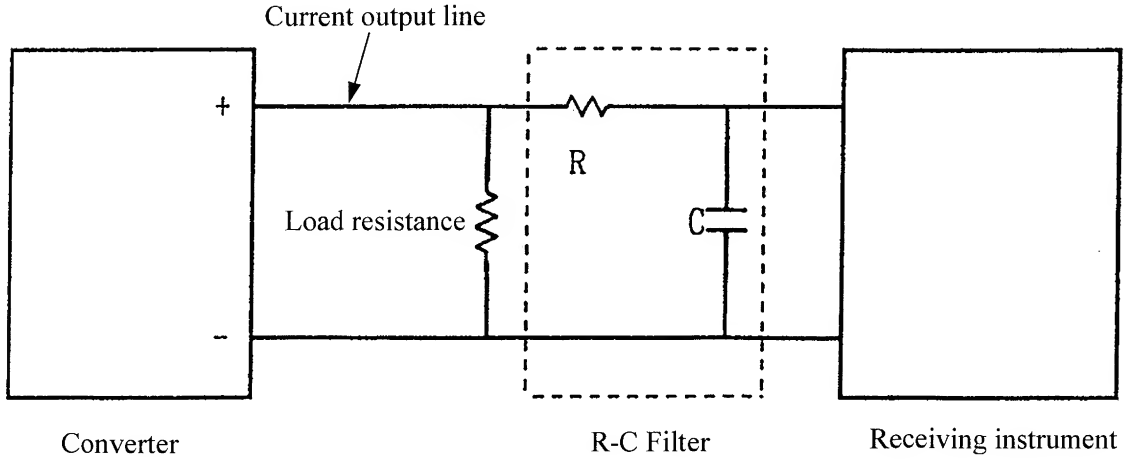


Figure 10.3 Filter connection example

11. Self-Diagnostics and Warning Functions

Self-diagnostic items and their warning messages are described below.

11.1 Self-diagnostics

The LF502 converter has a self-diagnostics function to detect such problems as a setting error, I/O error or converter hardware failure and shows the resulting error messages on the LCD and/or a lighting indication on LED. The error or alarm messages and their corrective actions are described below.

■ Setting error

If you try to set the value or measuring unit out of the range specified for each item, one of the following error messages appears on the LCD. (ALM LED does not light.)

Error message	Description	Corrective action
*H. OVER SPEC.	Setting value exceeds the allowable high limit.	Try to set the value within the specified range.
*L. OVER SPEC.	Setting value stays below the allowable low limit.	
*H. OVER C RATE	Counting rate exceeds the allowable high limit.	
*L. OVER C RATE	Counting rate stays below the allowable low limit.	
*MULTI RNG ERR	Span is not appropriate for multi-range configuration.	Try to set the span as specified.

■ High and low limit alarms

If the flow rate reading goes out of the set range, one of the following messages appears on the LCD. The ALM LED also lights. If the high or low limit alarm enable/disable status is set to OFF, its alarm function (high or low) will be disabled. See 7.3.7, "High and Low Limit Alarms."

Alarm message	Description	Corrective action
H. ALARM	Flow rate reading exceeds the high limit.	Arrange so that the reading stays lower than the high limit.
L. ALARM	Flow rate reading stays below the low limit.	Arrange so that the reading stays higher than the low limit.

■ **Empty pipe alarm**

If the detector pipe is not filled with fluid, the following message appears on the LCD. The ALM LED also lights. Design piping so that the detector pipe is always filled with the fluid to be measured. If the empty alarm enable/disable status is set to OFF, this function will be disabled. See 7.3.8, "Empty Pipe Alarms."

Alarm message	Description	Corrective action
EMPTY	Detector pipe is not filled with fluid.	Arrange piping so that the detector pipe is always filled with fluid.

Precautionary notes on using the empty pipe alarm

(1) The flowmeter detects an empty pipe condition by monitoring the impedance and signal level between the flow signal lines connected to a pair of electrodes. Therefore, the following factors may trigger an erroneous empty pipe alarm:
- Opening or loose connection of flow signal lines
- The fluid to be measured carries plenty of bubbles
- The electrode is contaminated with non-conductive deposits

(2) If the flowmeter is not grounded properly or if it is in an environment where high electrical noise exists, the empty pipe alarm may not function properly. Under these conditions, reliability of flowmeter accuracy itself is not high. Try to ground the flowmeter securely to an independent good ground and relocate the cable runs to prevent noise from entering into the flowmeter circuit.

(3) If the fluid still remains in the detector pipe or the internal wall of the detector pipe is contaminated with electrically conductive deposits, the impedance between the signal lines will not go high and the empty pipe alarm may not work. In the event like this, try to use other means to detect an empty pipe condition (such as a pump stop signal or a signal from a valve).

■ **Converter hardware failure**

The system checks the internal circuitry at the time of power-up for all error items and checks continuously for the specified items as described below. If an error is detected, one of the messages shown in the table below will be displayed on the LCD. The ALM LED also lights If multiple errors occur, their messages will be displayed cyclically. The diagnostics items about the excitation cable and excitation circuit are detected using the ADC circuit. Therefore, if the ADC fails, No. 4 (excitation cable) and No. 5 (excitation circuit) errors cannot be detected correctly. Also, this entire checking system is based on the CPU in the flowmeter. Therefore, if the CPU fails, no accurate diagnostics and error message display can be obtained.

No.	Error message	Description	Corrective action
1	*ROM ERROR*	ROM error	Internal components or printed-circuit board must be repaired or replaced. Contact your nearest Toshiba representative.
2	*RAM ERROR*	RAM error	
3	PARAMETER FAIL	System parameter error	
4	EX. CURR. OPEN	Excitation cables are not connected.	Connect the excitation cables correctly.
5	EX. CURR. ERROR	An error occurred in the excitation circuit.	Internal components or printed-circuit board must be repaired or replaced. Contact your nearest Toshiba representative.
6	ADC. ERROR	ADC error	
7	REF. ERROR	An error occurred in the reference voltage generation circuit.	
8	CHK. CIR ERROR	An error occurred in the signal voltage checking circuit.	
9	INVALID TOTAL	Totalized flow data was destroyed due to external noise. (No message appears if a measuring unit is not shown on the display.)	The error message disappears if you press the CLR (reset) switch.

NOTES

1. No. 1 and No. 2 errors can be detected only at the time of power-up. The flowmeter does not start measurement if any one of these errors is detected. If these errors occur after power-up, the flowmeter cannot detect these errors and thus, may indicate and output incorrect data.
2. No. 4 to No. 8 errors may not be detected even if the error may result in incorrect flowmeter accuracy because of characteristic differences of components used to detect these errors.
3. The CPU error cannot be detected. If the CPU stops, the watchdog timer resets the internal circuits and the flowmeter starts again from the initial power-up condition. Depending on the CPU condition, the flowmeter may not indicate and output correct data.

11.2 Output Status for Errors and Alarms

The flowmeter data display, current and pulse outputs will become as follows if an error or alarm occurs.

Error or alarm message	Data display	Current output (4–20 mA)	Totalized flow pulse output	Remarks
ROM ERROR (Note 1)	———	4 mA	Stopped	After power-up, no measurement starts.
RAM ERROR	———	4 mA	Stopped	
PARAMETER FAIL	Zero	4 mA (Note 2)	Stopped	———
EX. CURR OPEN	Zero	4 mA	Stopped	Zero adjustment (on-stream at zero flow rate) cannot be conducted.
EX. CURR ERROR	Measured data	Measured data	Measured data	———
ADC. ERROR	Zero	4 mA	Stopped	———
REF. ERROR	Zero	4 mA	Stopped	———
CHK. CIR ERROR	Measured data	Measured data	Measured data	———
INVALID TOTAL	Measured data	Measured data	Measured data	The error message disappears if you press the CLR (re-set) switch.
EMPTY	Zero	4 mA	Stopped	Zero adjustment (on-stream at zero flow rate) cannot be conducted.

Notes

1. The display and output may not be as indicated depending on the condition of ROM error.
2. If parameters related to the current output are defective, the current output may not be exactly 4 mA.

12. Maintenance and Troubleshooting

⚠ WARNING	
■ Do not work on wiring when **power is applied**. DON'T Wiring while power is applied can cause **electric shock**.	■ Do not touch the LF120/LF502 main body when **high temperature fluid** is being measured. DON'T The fluid raises the main body temperature and can cause **burns.**

12.1 Maintenance

■ Calibration

The LF502 converter has a reference signal generating circuit. This reference signal can be used to check the zero and span of the converter for the purpose of instrumentation maintenance or a periodical inspection. See Chapter 8, "Calibration."

■ Checking or replacing fuse

Fuse can be taken out by unscrewing the cap of the fuse holder. Check if the fuse is not damaged. Fuse has to be replaced periodically. A recommended replacement period is 3 years.

Type of fuse used: Glass tube fuse (Type: M) 2 pieces
Rating: 2A, 250 V
Dimensions: Dia. 5.2 mm × 20 mm

■ Components replacement

Electronic components deteriorate faster when the ambient temperature is high. The life for the display unit and power supply unit in the converter is 9 to 10 years if the ambient temperature is 40° C, and 5 to 6 years if it is 50° C. To use the flowmeter for a longer period of time, we recommend you to replace these components earlier. Contact your nearest Toshiba representative for a flowmeter inspection or components replacement.

■ Cleaning the inside of the detector

If the fluid to be measured contains a high concentration of electrically conductive solids, the solids may be accumulated as deposits on the internal wall of the detector pipe. The deposits causes the flowmeter to lower its measuring output. If the measuring output is lower than the actual process value, check for deposits on the internal wall of the detector pipe. If found, remove the deposits using a soft brush. Clean the inside of the detector periodically for this kind of fluid.

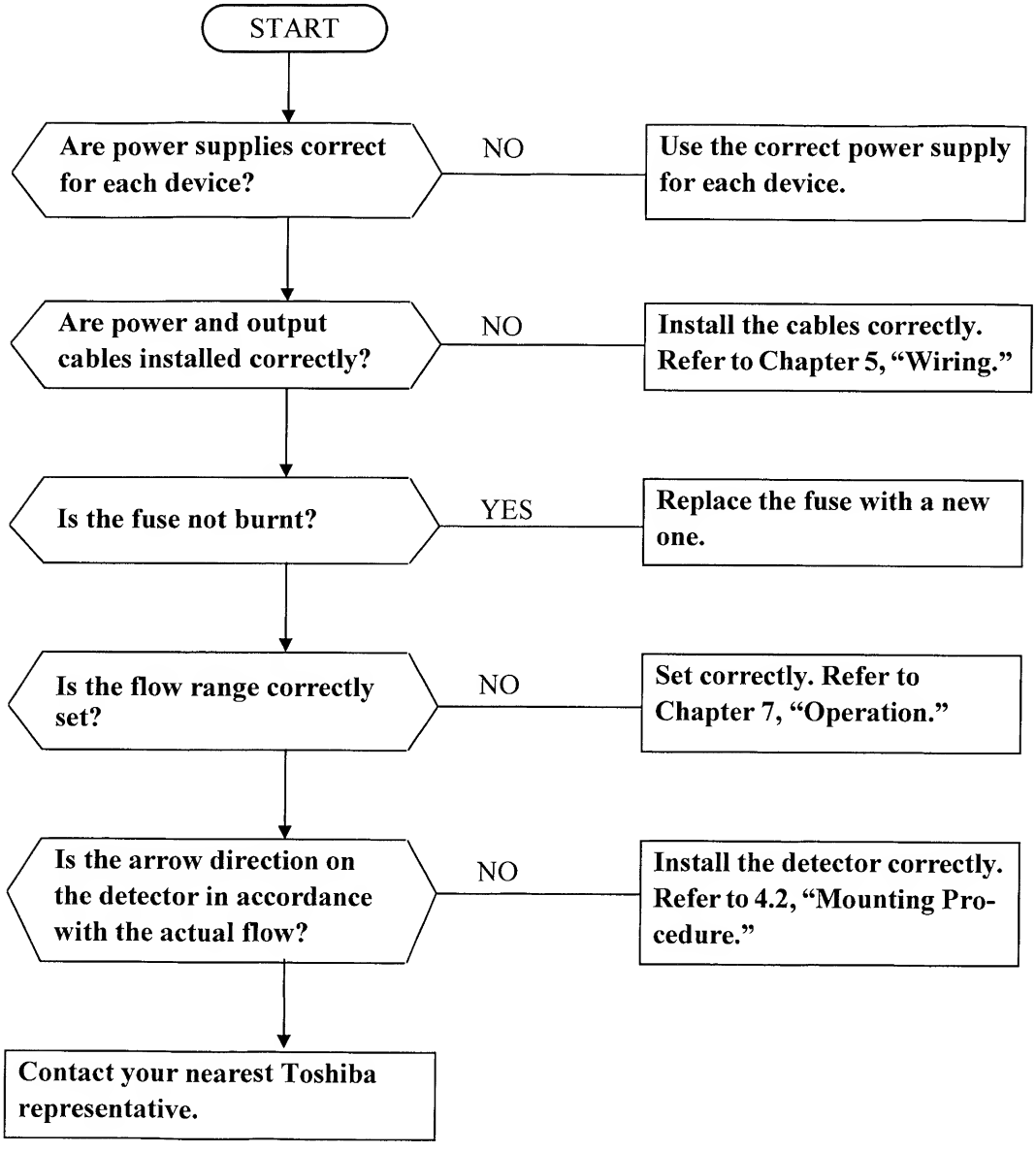
IMPORTANT

- It is recommended that the detector pipe should be cleaned once a year.
- Use always new packings when mounting the flowmeter detector in the pipeline.

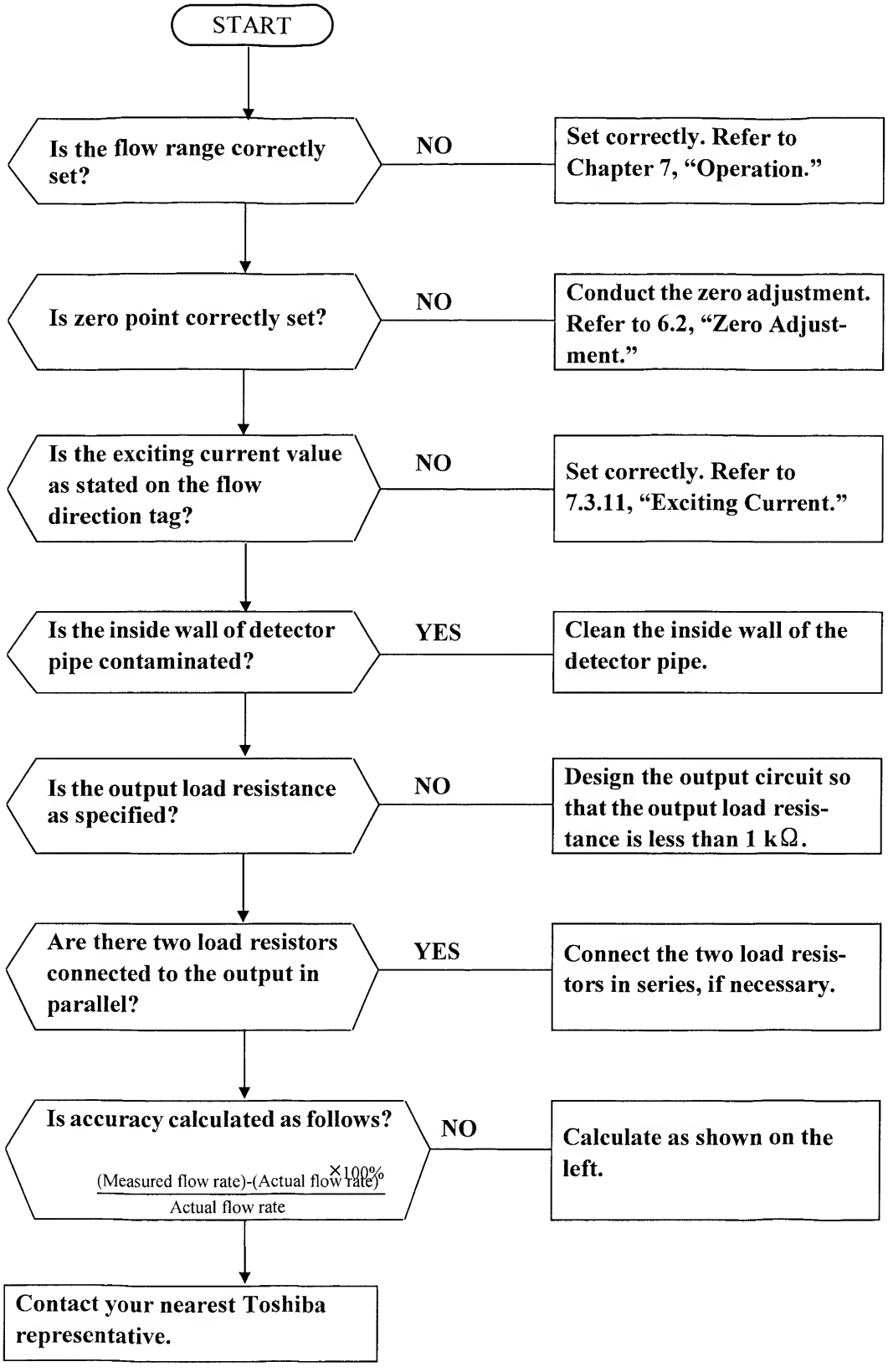
12.2 Troubleshooting

If a problem occurs while using the LF502, follow the flowcharts described below. You may find a way to solve the problem. The flowcharts are based on three symptoms (1) to (3). If you cannot solve the problem, contact your nearest Toshiba representative.

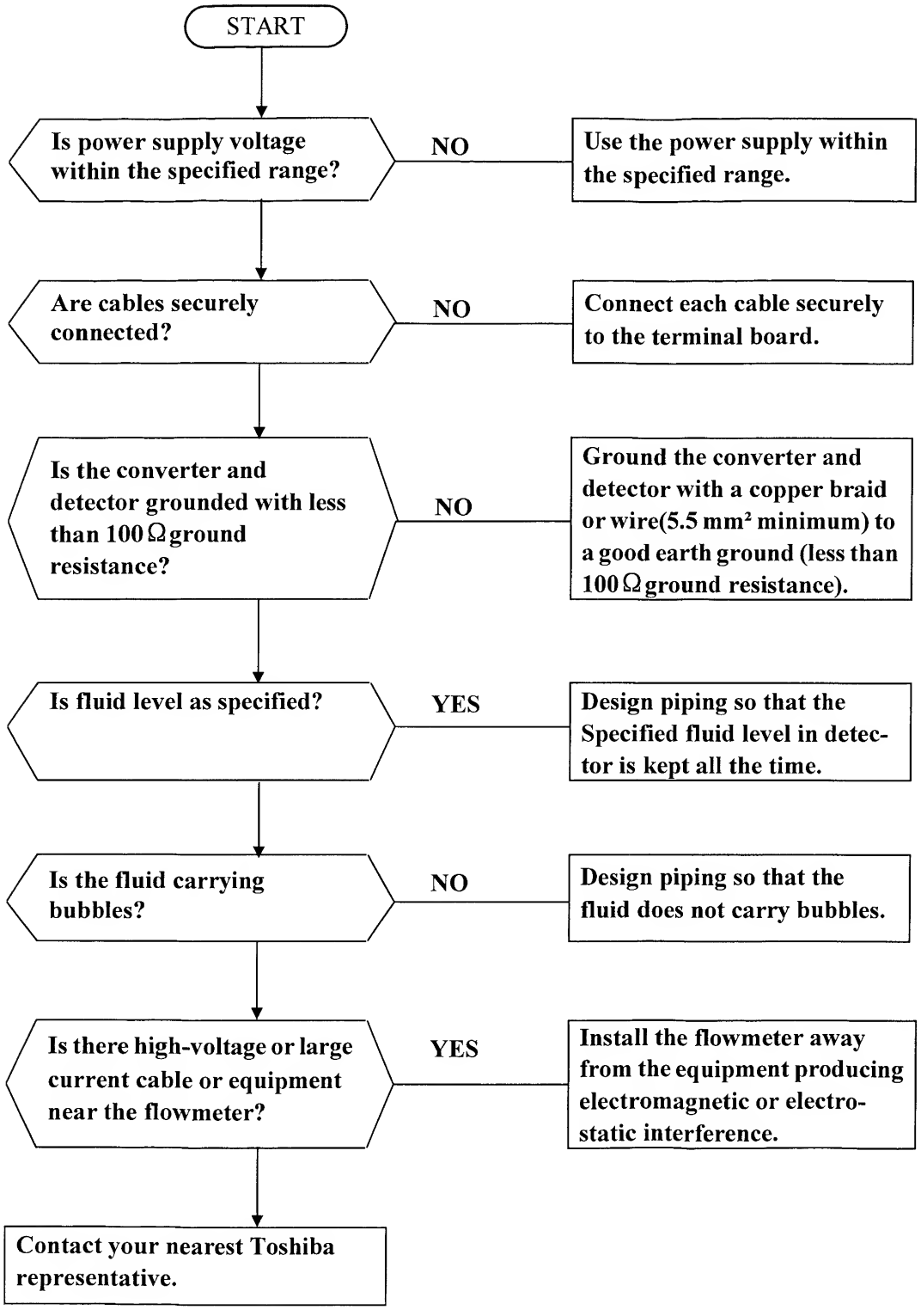
(1) Flow rate is not indicated.



(2) Flow rate indication is not correct.



(3) Flow rate indication is not stable.



13. Principle of Operation

Electromagnetic flowmeter is used to measure the volume flow rate of fluid applying Faraday's electromagnetic induction law. When conductive fluid is supplied to the insulating (measuring) pipe located at the right angle to the magnetic field as shown in Figure 13.1, signal electromotive force proportional to the average flow velocity is generated to flow directions of magnet and fluid.

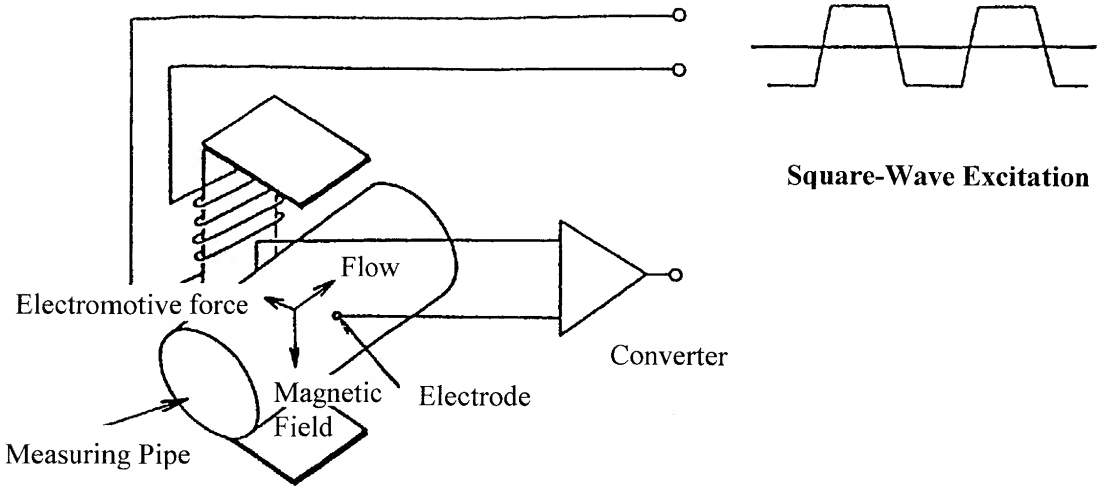


Figure 13.1 Principle of Operation

Model LF502 is adopting new methods to electrodes and coil wiring to detect signal electromotive force when the measuring pipe is not full with fluid and measure flow rate from low to full level with high accuracy. Also featured is square wave excitation method that may not be affected by static and electromagnetic induction noise and it prevents electrochemical polarization between electrodes and fluid that enables stable use for longer lifetime.

14. Specifications

The flowmeter specifications and the type specification code used when ordering the flowmeter are described in this chapter.

14.1 Flowmeter Specifications

■ Overall Specifications

Measurement range:

Meter size in mm (inch)	Measurement range
150mm (6")	0 - 60 m^3/h (std) to 0 – 300 m^3/h
200mm (8")	0 - 110 m^3/h (std) to 0 – 550 m^3/h
250mm (10")	0 - 175 m^3/h (std) to 0 – 875 m^3/h
300mm (12")	0 - 250 m^3/h (std) to 0 – 1250 m^3/h
350mm (14")	0 - 350 m^3/h (std) to 0 – 1750 m^3/h
400mm (16")	0 - 450 m^3/h (std) to 0 – 2250 m^3/h
500mm (20")	0 - 710 m^3/h (std) to 0 – 3550 m^3/h
600mm (24")	0 – 1000 m^3/h (std) to 0 – 5000 m^3/h

Fluid-level range:

- 30mm(1 1/4") to fully-filled condition for Meter sizes 150mm(6") to 300mm(12")
- 10% of inside tube diameter fully-filled condition for Meter sizes 350mm(14") to 600mm(24")

Accuracy: ±2 % (when measurement range is standard)

Note: The accuracy above is measured under the standard operating conditions at Toshiba's calibration facility.

Required straight pipe length:

10D minimum on upstream side and 5D minimum on downstream side

Note: D is a nominal meter size.

Fluid conductivity: 100 μS/cm minimum

Fluid temperature: –10 to 55 °C (32 to 131 °F)

Ambient temperature: –10 to 50 °C (14 to 122 °F)

Dimensions and Mass: See Chapter 15, "Outline Dimensions."

■ Detector

Meter size: 150 mm (6"), 200 mm (8"), 250 mm (10"), 300 mm (12"), 350mm (14"), 400 mm (16"), 500 mm (20"), 600 mm (24")

Fluid pressure: 0 MPa to the pressure limited by the connection flange

Connection flange standard: See Table 14.3 Type Specification Code.

Structure: NEMA 4 (IP67) Watertight (standard)
NEMA 6 (IP68) Submersible (option)

Principal materials:

Case— Carbon steel

Lining—The following are the standard,
Teflon (PFA) for Meter sizes 150 mm (6") to 400 mm (16")
Chloroprene rubber for Meter sizes 500 mm (20") and 600 mm (24")

Electrodes—316L stainless steel (standard)

Grounding rings—316 stainless steel (standard)

See Table 14.5 Type Specification Code to select other materials for each item above.

Coating: Phthalic acid resin coating, pearl-gray colored (standard for watertight type) or black tar epoxy (option for watertight type and specified exclusively for submersible type)

■ Converter

Input specifications:

Analog input Voltage signal proportional to process flow rate comes from detector.

Digital input Voltage signal

Voltage signal specifications

H level: 20 to 30 V DC

L level: 2 V maximum

Input resistance: 2.7 kΩ

Number of inputs: One point

Function—One of the following functions can be selected for a DI signal:

- Remote selection of unidirectional flow multi-range
  (The H level signal selects the smaller range of the existing two ranges. Refer to 9.3, (3).)
- Remote selection of bidirectional flows multi-range
  (The H level signal selects the smaller range of the exiting two ranges for each direction. Refer to 9.3, (4).)
- Totalized flow counter Start/Reset
  (The H level signal starts the totalized flow counter and the L level signal clears (resets) the counter.)
- Zero adjustment (on-stream at zero flow rate)
  (The L level signal after staying in the H level for 10 to 20 seconds starts the zero adjustment. See 9.7, "Remote Zero Adjustment.")
- Fixed-value output
  (The H level signal selects the fixed-value output. See 9.8, "Remote Selection of Fixed Value Output.")

Output specifications:

Analog output

Current signal	4 to 20 mA DC
Load resistance	0 to 1 kΩ

Digital output

Output type	Semiconductor contact output (no polarity)
Output capacity	150 V DC, 150 mA maximum; 150 V AC, 100 mA (peak) maximum
Number of outputs	Two points

Functions Two of the following functions can be selected for DO1 and DO2:

- Pulse output for totalization (DO1 only)

  Pulse rate 3.6 to 360000 pulses/hr
  Pulse width 5 to 100 ms (but less than a half of the period for 100% flow rate

- Multi-range selection output

  One output is used (DO1 or DO2) (1) 2-range switching for unidirectional flow
  (2) Forward/Reverse flow range switching

  Two outputs used (DO1 and DO2) (1) 4-range switching for unidirectional flow
  (2) 4-range switching for Forward and Reverse flows

- High and low limit alarms—outputs an alarm signal if the process flow rate goes above or below the set limits.

  Valid range: –10 to 110% of the span (range)
  Output status: Contact ON (closed)

- Empty pipe alarm—outputs an alarm signal when the detector pipe is not filled with fluid.

  Output status: Contact ON (closed)

- Preset point output—outputs a signal when the totalized flow counter reaches the preset value.

  Valid range: 1 to 999999 counts
  Output status: Contact ON (closed)

- Converter failure alarm—outputs a signal if the converter has an error other than a high/low limit alarm or an empty pipe alarm

  Converter failure output: Contact ON (closed)

See the following table for a combination of functions selectable for DO1 and DO2.

Table 14.2 DO1 and DO2 selectable functions

DO1 \ DO2	Multi-range output	High alarm	Low alarm	Empty pipe	Preset point	Converter failure
Pulse output	○	○	○	○	○	○
Multi-range output	○	○	○	○	○	○
High alarm	—	—	○	○	○	○
Low alarm	—	—	—	○	○	○
Empty pipe	—	—	—	—	○	○
Preset point	—	—	—	—	—	○

○ Possible — Not possible

Communications output:

a small digital signal is superimposed on 4-20 mA current signal (conformed to HART protocol)

Load resistance: 240 to 1 kΩ

Load capacitance: 0.22 μF maximum

Display: Liquid crystal display (backlight provided)

- 16-character × 2 lines
- Two sets of data (flow rates, totalized flow value) can be displayed in various engineering units

Damping: 5 to 600 seconds (in 10 seconds increments)

Parameter setting: Parameters can be set using key switches.

Zero and span calibration:

A built-in reference signal circuit in the converter is used to calibrate the zero and span of the converter itself.

Zero adjustment:

Zero adjustment can be performed on-stream with zero flow rate condition. This operation can be started with a simple key operation.

Conditions when power fails:

Setting values are stored in non-volatile memory.

Current output 0 mA DC

Liquid crystal display No display

Digital output OFF

Power supply:

One of the following can be selected:

100 to 120 V AC (90 to 132 V AC), 50/60 Hz,

200 to 240 V AC (180 to 264 V AC), 50/60 HZ, (option)

21 to 27 V DC (option)

Power consumption: approximately 24 VA

Surge protection: Surge protectors are installed in the power supply and current signal output circuits.

Housing: Cast aluminum

Coating: Melamine resin-baked coating, Light gray colored

Dimensions and Mass: See 13. Outline Dimensions.

Structure: NEMA 4 (IP67) Watertight

Cable connection port: Rc(PT) 3/4 male screw

Vibration resistance:

No resonance to the following levels of vibration:

- 5 to 33 Hz with acceleration of 9.8 m/s^2.

Note: Avid using the flowmeter in an environment with constant vibration.

14.2 Type Specification Code

Table 14.3 Type Specification Code

Model	Specification Code									Description	Size (mm)	
1 2 3 4 5	6	7	8	9	10	11	12	13	14			
L F 5 0 2										LF502 Electromagnetic Flowmeter	150 to 400	500, 600
	K									Meter size 150 mm (6") 200 mm (8") 250 mm (10") 300 mm (12") 350 mm (14") 400 mm (16") 500 mm (20") 600 mm (24")		
	L											
	M											
	N											
	P											
	Q											
	R											
	S											
		C								Connection flange standard ANSI 150 BS 4504 Table 16 DIN PN 16 JIS 10K other		
		F										
		H										
		J										
		Z										
			B							Electrode and Grounding Ring Material 316L + 316 stainless steel 316L + 316L stainless steel Ti (titanium) + Ti (titanium) Hastelloy C + Hastelloy C 316L + 304 stainless steel other	●	○
			C								○	○
			D								○	○
			E								○	○
			F								○	●
			Z									
				T						Lining Material Teflon PFA Chloroprene rubber other	●	-
				C							○	●
				Z								
					A					Power supply 100 to 120 V ac, 50/60 Hz 24 V dc 200 to 240 V ac, 50/60 Hz	●	●
					B						○	○
					C						○	○
						A				Converter Mounting Bolts and Nuts Panel, wall mount (carbon steel SS400) Panel, wall mount (304 stainless steel) Pipe mount (carbon steel SS400) Pipe mount (304 stainless steel) other	●	●
						B					○	○
						C					○	○
						D					○	○
						Z						
							A			Detector connection Bolts, Nuts and Packings not provided other	●	●
							Z					
								A		Dedicated Preformed Cable 30 m provided other lengths, provided	●	●
											○	○
									B	Coating Phthalic acid resin Black tar epoxy resin 0.3 mm Black tar epoxy resin 0.5 mm Black tar epoxy resin 0.5 mm for Submersible type other	●	●
									C		○	○
									D		○	○
									E		○	○
									Z			

● Standard ○ Option — Not available

Notes:

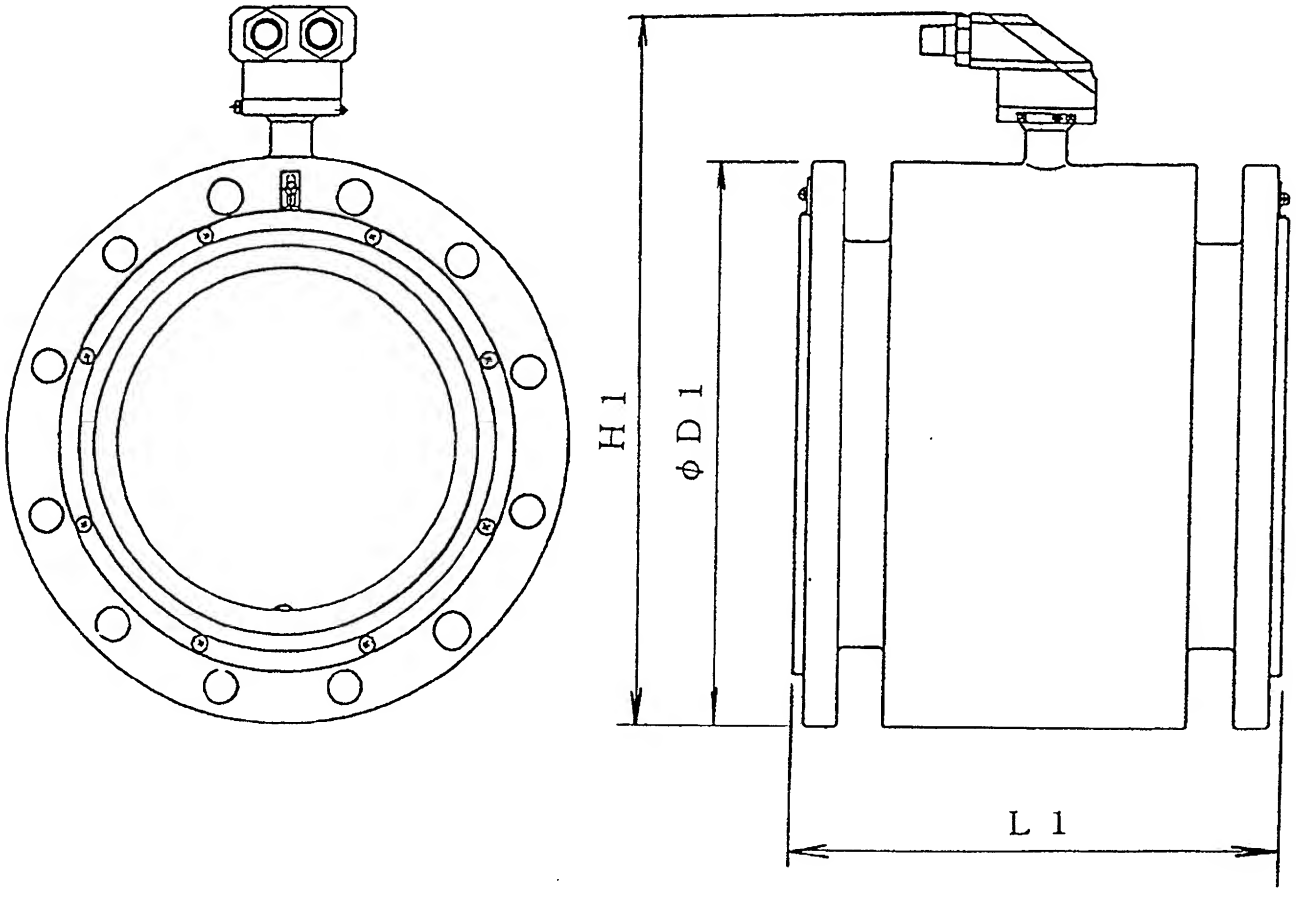
1. Standard materials from Table 12.3 about BNP are provided.
2. Specifying this code, select desired materials from Table 12.3 about BNP.
3. As to meter sizes 15, 150 and 200 mm, designate coating specifications.

Table 14.4 Type Specification Code (Bolts, Nuts and Packings)

Model	Specification Code							Description
1 2 3	4	5	6	7	8	9	10	
B N P								Bolts, Nuts and Packings
	F							Flange connection type
		0	1	5				Meter size 150 mm (6")
		0	2	0				200 mm (8")
		0	2	5				250 mm (10")
		0	3	0				300 mm (12")
		0	3	5				350 mm (14")
		0	4	0				400 mm (16")
		0	5	0				500 mm (20")
		0	6	0				600 mm (24")
					C			Pipe flange rating ANSI 150
					F			BS 4504 Table 16
					H			DIN PN 16
					J			JIS 10K
					Z			other
						A		Bolt and Nut Material Steel (galvanized)
						B		304 stainless steel
						C		not provided
						Z		other
							A	Packing Material EPDM rubber (standard)
							C	Teflon-enclosed gasket
							C	not provided
							Z	other

15. Outline Dimensions

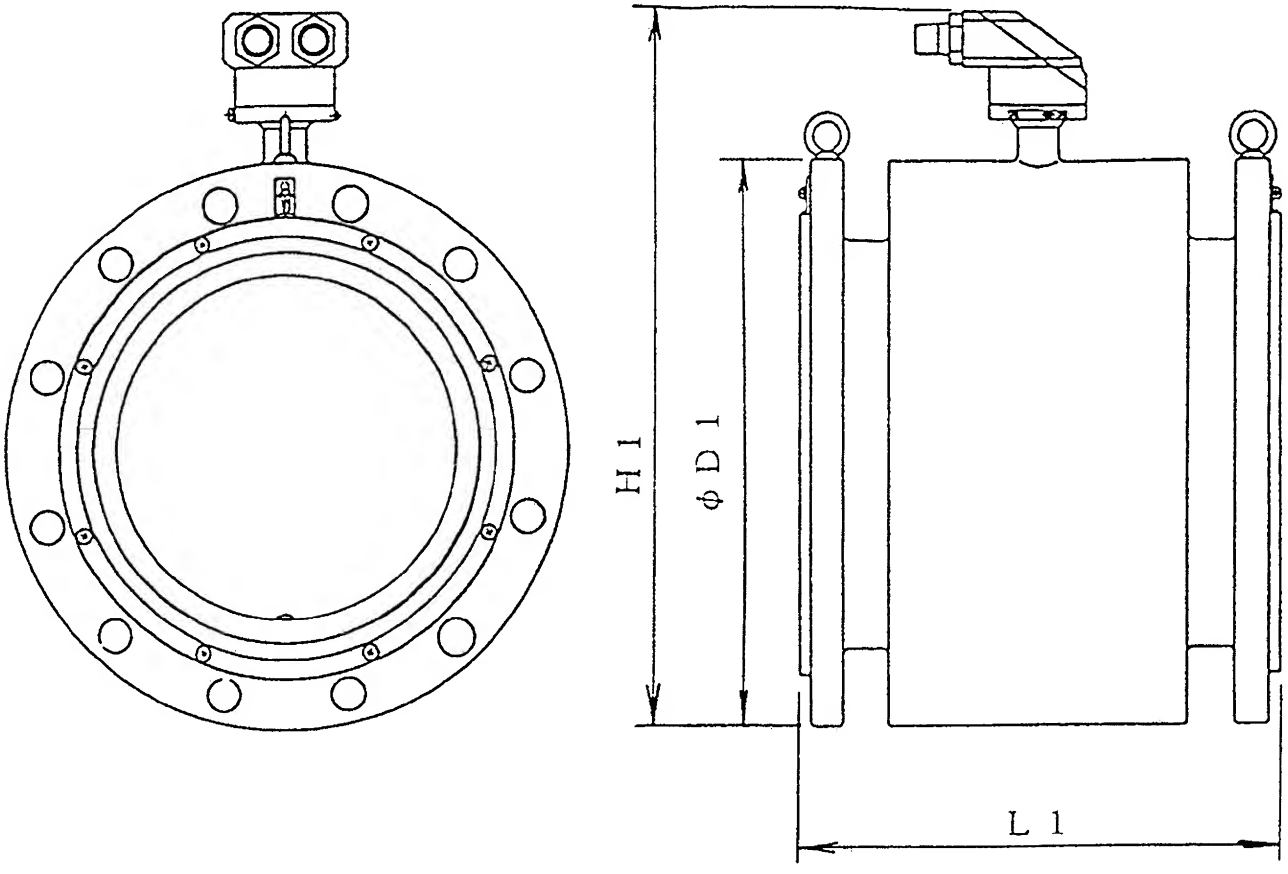
■ **Meter size 150mm and 200mm**



*Dimension for ANSI 150

Diameter		D1		L1		H1		mass
mm	inch	mm	inch	mm	inch	mm	inch	kg
150	6	279	10.98	266	10.47	385	15.14	35
200	8	343	13.50	300	11.81	443	17.42	80

■ **Meter size 250mm and 300mm**



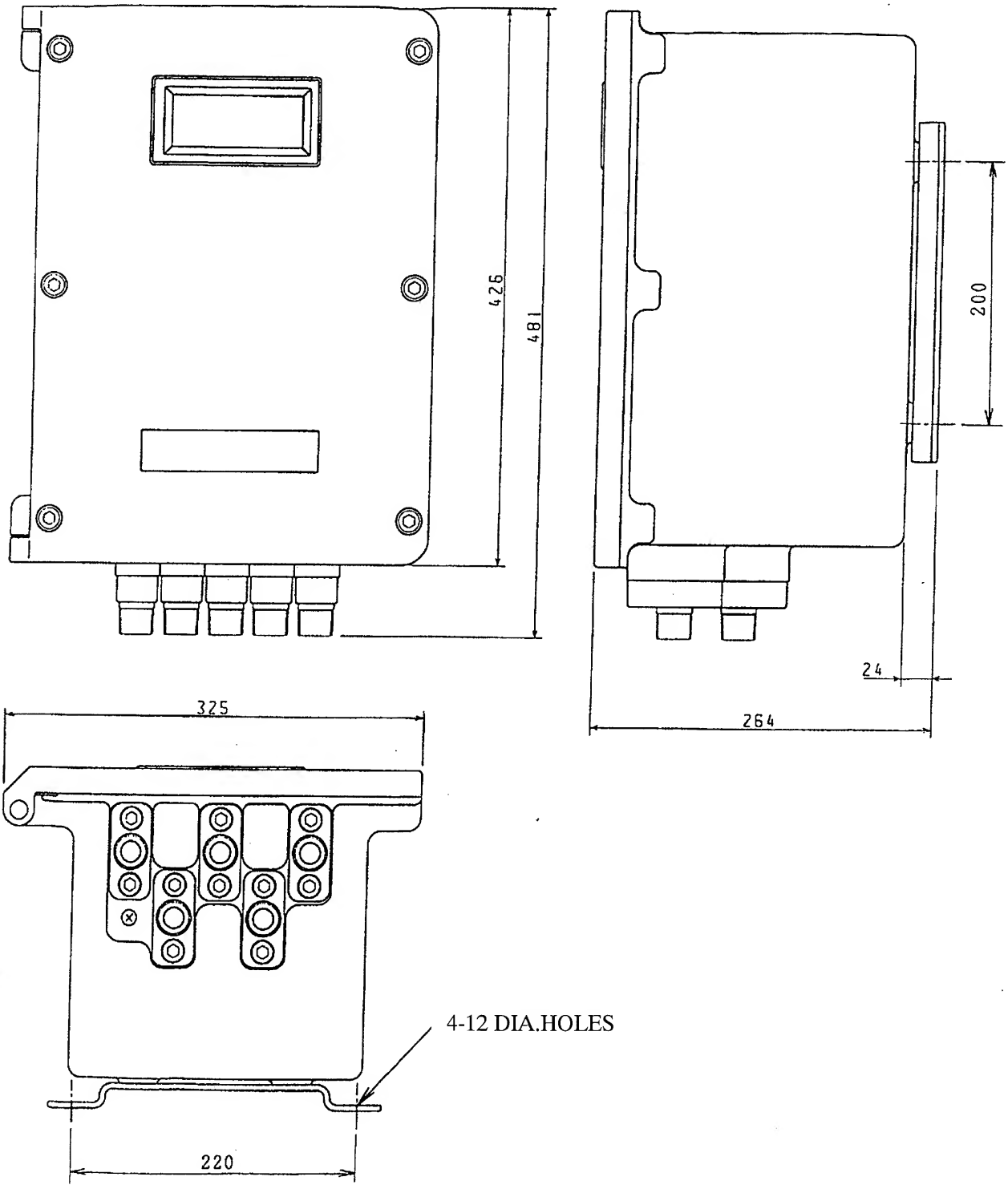
*Dimension for ANSI 150

Diameter		D1		L1		H1		mass
mm	inch	mm	inch	mm	inch	mm	inch	kg
250	10	406.5	16.00	350	13.78	509	20.05	110
300	12	483	19.02	400	15.75	590	23.24	120

■ Converter

UNIT: mm

Mass: approx. 18 kg



USER'S FORM
NOTES

Unit purchased from	
Name	
Title	
Company	
Address	
City/State or Province	
Country	
Tel	
Fax	
Model/Specification Code	LF502
Serial No.	

Industrial Equipment Department
1-1,Shibaura 1-chome, Minato-ku, Tokyo, 105, Japan
Tel.: (03)3457-4900 Fax.: (03)5444-9268

TOSHIBA CORPORATION

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